THE AQUARIUM BOOK

OCTOPUS *v.* LOBSTER.

Frontispiece.]

THE AQUARIUM BOOK

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INTRODUCTION

A VAST library and not a few films have done much to make the wonders of the water-world a living reality to the stay-at-home landsman. But the up-to-date aquarium has gone further. It has made it possible to practically walk dry-shod along the river-bed or ocean-floor, and see life as it is below the surface at first hand.

Take a typical tank in the great sea-water hall at the Zoo's Aquarium in Regent's Park. Here is a big expanse of shining sand, backed by towering rocks, the whole enveloped in thousands of gallons of sea-water. Sand, rocks, and water all teem with life. From the sand peer the rolling eyes of flat-fish, buried but for their shining orbs. Here and there the waving feelers of submerged crabs, or the stubble-like clumps of worm tubes, each with a tuft of crimson plumes protruding from an opening at the top, are to be observed. The rocks are covered with anemones, flower-like creatures rivalling in form and colour the choicest blossoms of Kew. And in the all-enveloping water move the fish. Some appear almost fairy-like in their delicacy, whilst others startle one with their vivid liveries. There are fish that glide, dart, crawl,

and even climb. Fish that we at once recognize, and fish that recall heraldic monsters from some ancient tapestry. Here in the heart of London is exhibited the flaccid merchandise of the fishmonger's slab, transformed into a fairy-like deep-sea ballet,—a sight, outside of the aquarium, only enjoyed by the diver.

How is it all produced?

* * * * *

The answer covers many hundreds of years of endeavour and experiment. Of man's first attempt to keep fish under observation we have of course no record. It probably amounted to the blocking up of some rock gully, and the retention of the fish contained therein until wanted, as is still done in different parts of the world. Originally aquatic animals were kept solely for the table, and even the great aquariums of to-day play an important part in our food supply, by acquiring knowledge which helps in framing our fishery laws.

From the old Roman times onwards the fish-pond, the great ancestor of the modern aquarium, played an important part in economic history. The Romans farmed fish, as they did most things, on the grand scale. Enormous sums were often spent on the construction of their fish-ponds, the ponds being sometimes connected by a canal to the great man's kitchen and banqueting halls. At the banquets the living fish would often be exhibited alive in aquaria. The fish-ponds, so it has been recorded, were occasionally put to more

sinister uses, inconvenient politicians and refractory slaves meeting a fearful death in a seething mass of conger-eels and lampreys. Even before the Roman period, the Chinese were ardent fish-farmers, producing " fancy " breeds which to this day delight us. All the public aquaria of the Orient, however, have, strangely enough, been introduced by Western influence. At home the fish-pond attained to a great importance in mediæval times. Every monastery, abbey, and castle possessed one, or an encircling moat which served as a protection as well as a fish preserve. Friday is not the day for fish-fare that it was, at least in England, and the demand for home-killed fresh-water fish has in consequence practically ceased. Large quantities of pike, carp, tench and perch are, however, imported alive from France and Holland for sale in the Jewish quarters of our big cities.

The relationship which animals and plants bear to each other is nowadays taught in almost every elementary school. In the old days so long as fish were kept in outdoor ponds or caged in streams the water became well stocked with plants, and the " balance of Nature " adjusted itself automatically. When, however, attempts were made to keep aquatic animals indoors in confined spaces the necessity for this " balance " became manifest. It is less than a century ago that the chemist Priestly demonstrated that the gases given off by plants were utilized by animals, and vice versa. Soon naturalists all over the world were verifying and

elaborating this apparently simple discovery, and applying its principles to aquaria, which were then chiefly of the jam-pot variety. In 1850 Philip Henry Gosse, a pioneer aquarist, felt sufficiently sure of his ground to help establish an aquarium on somewhat more ambitious lines. This was done in what is now the Wading Bird House in the London Zoological Gardens. The keeping of small aquaria soon became a cult, not only in public institutions, but in thousands of homes. Many of these early enthusiasms cooled later, but from thence onwards the general progress of aquarium-keeping was assured. Later contemporaries of the Zoo's effort were the Surrey Gardens and the Dublin Aquarium, the latter unique in that its tanks were fitted with bellows which the public were called upon to use, and thus whilst enjoying the exhibits, assisted in aerating the water containing them. London and Dublin's example was presently followed by Belfast, Edinburgh, Scarborough, Yarmouth, Boulogne, Havre, Berlin, Cologne, Hamburg, Hanover, Brussels, Vienna and Boston. Most of these aquaria were quite small. The one at Hamburg and which is still in existence, was at the time of its erection considered an aquarium " de luxe." It was designed in 1864 by Mr. William Lloyd, who later became curator of the large Crystal Palace Aquarium. Manchester and Southport followed suit, the movement culminating in 1872 in the Brighton Aquarium, the biggest institution of its kind in the world, one of its tanks

lone holding 110,000 gallons. About this time Mr. Lloyd and Professor Anton Dohrn founded the famous Aquarium at Naples. This wave of enthusiasm for aquaria, which had but a short life, created new industries,—fish and water-plant culture, aquarium construction and engineering, etc.

Most of the above-mentioned public aquaria have now vanished, and in their stead have arisen the biological stations at Plymouth, Lowestoft, Aberdeen, to mention only a few, where the harvest of our seas are investigated and safeguarded.

The old Westminster Aquarium,—its site now covered by the Central Hall,—will be remembered by many, but regretted by few. As an aquarium it was a failure from the start, and soon after its opening, sword swallowers, contortionists, two-headed nightingales and other monstrosities and music-hall turns were introduced to augment the waning attractions of the fish. Towards the close of its existence it became the "rendezvous" of a none-too-reputable public, there being more "queer fish" outside than inside the tanks.

The small Zoo and Crystal Palace aquaria were also abandoned, and from about 1890 to 1924 London was without a first-class aquarium. It was not until 1922 that it became possible for the Zoological Society to repeat its pioneer effort of 1850. Many will be acquainted with the public gallery as it now stands beneath the Mappin Terraces. Let us, however,

make a hurried survey of the entire institution, public and service. The Aquarium occupies the whole of the great semicircular space beneath the terraces. It took nearly two years to design and build, and cost about £55,000. The entrance at the east end leads into a large vestibule with a fish-pool and rockery. The turnstile leads directly into the public corridor, which consists of three halls devoted to fresh-water, marine, and tropical fresh-water exhibits. As the bulk of this volume surveys aquatic life as mirrored in the Zoo tanks we need not dwell longer in the public gallery. Before leaving it, however, it is worth pointing out that unlike in the case of many large aquaria where the illumination of the tanks is marred by allowing diffused light to penetrate into the public corridor, at the Zoo the visitors are in almost complete darkness and the tanks set in deep bays are lighted from above from an invisible source. As a result a series of brightly illuminated pictures of the underwater-world is obtained. There are in all about 100 tanks varying in size from one to thirty feet in length, the largest having a 5,000-gallon capacity. A staircase on the right of the vestibule leads to the research laboratory and the service gallery. The latter is a wide stone corridor on a level with the top of the tanks. Many aquaria have no service corridor, the tanks being spanned by planking, an unsatisfactory arrangement which has resulted in more than one keeper astonishing the public by suddenly appearing amongst the exhibits. The tanks are

onstructed of slate or concrete, and the glass—in some ases an inch and a quarter thick—is held in position ith mastic and a layer of thin rubber which allows for certain amount of expansion.

Visitors are usually impressed by the clarity of the ater. This is, of course, vital to the successful exhiition of aquatic life, and is the result of considerable are. The sea-water was originally brought in the allast tanks of steamers from the Bay of Biscay. At ne docks it was transferred to drinking barges, and arried to the Zoo via the Regent's Canal. On arrival was pumped through a 650-foot-long hose directly nto the enormous reservoirs beneath the Aquarium. he water is kept in constant circulation and should ot need entirely replenishing for many years. It is umped from an underground reservoir which has in ne case of the sea-water a 120,000-gallon capacity, in ne case of the fresh-water a 60,000-gallon capacity, o other smaller reservoirs situated in the peaks of the Mappin Terrace mountains. From these high storage anks, the water falls by gravity into the show tanks, ne overflow passing through a series of sand filters efore returning underground. Oxygenation of the ater is chiefly obtained by discharging the water nto the exhibition tanks with great force through pipe with a very small aperture, the resulting air ubbles being very small and producing the effect of a moke cloud. The aquaria are also aerated by passing ompressed air directly into them. Not only is the

water cleansed by being passed through the filters, but the tanks themselves are kept scrupulously clean. At the Zoo most of them are carpeted with sand on which dead animals, decaying vegetable matter, rejected food, and excrement are easily detected and immediately removed. The purity of the sea-water is further ensured by a discrete choice of the metals used in the

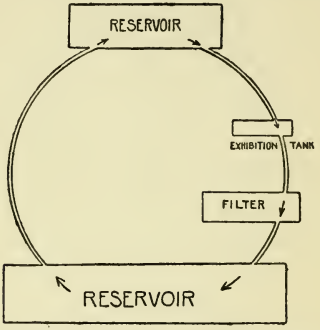


Diagram Illustrating System of Water Circulation.

piping and the building of the tanks, as if certain kinds, such as copper and zinc, came into contact with the sea-water the exhibits would be speedily poisoned. Thus in the marine section the iron drainage pipes are all lined with enamel, whilst other piping is made of chemically pure lead.

A variety of nets is employed to remove the fish from their tanks, although many are so tame that they can be caught up by hand.

Decaying matter is removed by means of a suction pipe lashed to a pole, the easier to manipulate it. The sides of the glass inside the tanks may become coated with algæ, and this is cleaned off with a rubber mounted on a broom handle, a board being placed across the tanks to act as a fulcrum.

Although the food of aquarium fish and the methods of feeding will be dealt with in the subsequent chapters, a word on the general methods employed at the Zoo may not be out of place here and welcomed by the amateur aquarist. Horses' heart figures largely on the menu. Finely shredded, this makes an admirable substitute for fish or worms and is often accepted by creatures believed to be confirmed vegetarians. Sand-hoppers and shrimps are also used, some of the latter being " grown " on the premises. Many shrimps escape from time to time down the overflows of the show tanks through the pipes leading to the filters, where, immune from foes, they have established an ever-increasing colony. The fresh-water flea, *Daphnia*, is welcomed by many fish, this tiny crustacean being bred in large quantities in the alligator and crocodile tanks in the reptile house. They are indeed farmed by certain dealers and can be purchased in any quantities.

Vegetable feeders, such as carp and tench, will never starve provided their tank is kept well stocked with plants. For small fresh-water fish, apart from *Daphnia*, small earth worms, the red larvæ of the midge *Chironomus*, which are commonly known as

" bloodworms," the fresh-water shrimps *Gammarus*, and the white thread-like worms *Enchytrae* are the best foods. Except when quite fresh, ants' eggs with which goldfish are so often provided are quite valueless. Live food has the great advantage over all artificial fish food since if not eaten at once it need not be removed, as it will thrive and be consumed on some future occasion.

The way to an animal's heart is usually through its stomach. Fish are no exception to the rule, and a peep behind the scenes at the Zoo's Aquarium makes it very evident that the majority can in time be persuaded to display considerable trustfulness—at least at feeding time, when they are on the best of terms with their keepers. The Zoo carp will take bread, biscuits, and even monkey-nuts from the hands of complete strangers, whilst the appearance of a keeper with a dish of food produces a joyful riot in most of the tanks. At the Regent's Park Aquarium the fish will not only feed from the hand, but in some cases even allow themselves to be taken out of the water. A six-foot-long conger having been fed never raises the slightest objection when he is lifted bodily from his native element, whilst cod, small skate, gurnard and a host of other fish will practically nestle in the outstretched palm. The crawfish clamber from their tanks in a body at the sight of food, and take their daily ration from their keeper's fingers.

At the Brighton Aquarium feeding time is always

heralded by a blast from a whistle which has the effect of inspiring many of the fish with a veritable hysteria, and gives rise to some interesting questions as to the powers of hearing enjoyed by certain aquatic animals. The capture and transport of aquarium exhibits, especially the marine ones, presents many difficulties, of which the aeration of the water supply *en route* is the chief. On the journey a constant supply of air liberated from a compressor has to be introduced into the wooden or enamel travelling tanks—some of which, when full, weigh eight hundredweight, in order to keep the water fresh and the animals in sufficiently good condition to survive after their journey. Sometimes, from a mistaken idea of economizing space, specimens are herded together with disastrous results. Fish should be transported in carriers which are broad rather than deep, and the number per carrier should be low. Fifty gallons of water, if kept aerated, will support on a six-hour journey about 100 normally hardy fish of about 3 inches in length, or twenty-five fish 6 inches in length, and only three fish 1 foot in length. On arrival at their destination the fish should not be immediately transferred to the exhibition tanks, but the water in the carriers should be slowly substituted for that of the aquarium, which is bound to be of a slightly different nature and temperature. On the journey the association of unsuitable tank-mates should be avoided. As an example, a quantity of wrasse and rare crabs were recently dispatched to the Zoo Aquar-

ium from the coast. The travelling tank on arrival was found to contain only wrasse, the consignee being ignorant of the fact that of all delicacies crabs were those most appreciated by these fish.

The even temperature of the water is another essential. Except in the case of tropical and sub-tropical exhibits the average winter temperature should vary between 45° and 55°, whilst in summer it should not exceed 65°.

I will conclude this chapter with some more remarks of a practical nature which will, I trust, be of use to those whose ambitions have been aroused by a visit to the Zoo's Aquarium. If the novice will from the start, as far as possible, " follow nature," he will avoid the many pitfalls which usually lie in wait for the hasty or careless beginner. The choice of an aquarium is all important. The goldfish bowl, which is sold in thousands, is obviously the worst possible receptacle for any creature intended to enjoy life, since it violates every canon of Nature's aquaria—the rivers, lakes, and seas. An aquarium should present the greatest possible surface of water to the air in proportion to its size and depth. The rivers and seas are further lit only from above. This is ideal from the inhabitants' point of view, although not from the human observer's, who will wish to enjoy a diver's view of his aquarium, —to see it in elevation, rather than as a ground plan. This means that if the aquarium is rectangular in form, one side, and one side only should be of clear glass.

If the aquarium is of the bell-jar type, at least two-thirds of the glass should be screened with some opaque material. Nearly all the fish diseases and other troubles which exasperate the aquarist are caused, if not by sudden changes of temperature, by too much light.

Before introducing the water the aquarium should be carpeted with several inches of well-washed river sand. No other substance is so suitable, since the sand will not readily cloud the water or conceal waste products. Dead fish, decaying vegetable matter, excreta, etc., are at once visible and may be readily removed. In filling the aquarium disturbance of the sand may be avoided by pouring the water slowly into a jar stood in the middle of the tank, and made to enter slowly through a narrow-gauge siphon, the end of which is drawn out to a fine point, or controlled by a small tap.

Even in the present age of aquarium keeping there is a wide-spread belief that the water in the tank requires constant changing if it is to keep fresh. The water certainly must be kept pure, but no such violent methods of ensuring its purity should be employed. For most small fresh-water fish an aquarium well but not overstocked with plants and animals taken from still water, such as a pond, should not require further oxygenizing than that supplied by the plants. Artificial aeration may, however, be employed with advantage and is, of course, absolutely indispensable where animals taken from running water or the sea are concerned. It may be effected by liberating air into the

tank from a drum in which it has been compressed.

Whilst following nature as closely as possible it should be borne in mind when stocking the aquarium that however large the tank may be, it is after all a very small affair compared to even a pond or ditch, and that discretion must be used in the choice of " tank-mates." Scenes of carnage may be unavoidable in the wild, but are undesirable in the home. If " regrettable incidents " are to be avoided harmless vegetarians such as small carp or tench must on no account be placed in the same aquarium with aggressive carnivorous feeders such as pike or perch. In stocking the tank it is at first better to have too few, rather than too many exhibits. Additions can always be made from time to time until a perfect balance is struck, without overtaxing the tank's capacity. In fresh-water aquaria plants should be introduced, especially when the water is not circulated. Water Weed, *Anacharis*, Water Starwort, *Callitriche*, Swamp Plant, *Ludwigia*, Willowmoss, *Fontinalis*, Water Milfoil, *Myriophyllum*, are suitable plants obtainable in many ponds or ditches. The most valuable oxygenizer of all, however, is *Vallisneria spiralis*, which can be acquired from most aquarium dealers. The plants should be placed in position before the water is introduced, and their roots should be washed and embedded in the sand, or kept in position by little " sinkers " made of lead. Deep-rooting plants, such as the many kinds of miniature water-lily, should be installed in separate flower-pots.

An excess of light will not only cause the plants to become rank and sickly, but will also call to life the floating spores of undesirable algæ, which may cause the water to become opaque, and milky. It may also coat the glass with a green film, which if neglected will soon shut out the animals from their owner's view. The floating algæ may be checked by shading the aquarium for some time, whilst those coating the glass can be removed with a piece of wash-leather, shagreen, or rubber attached to the end of a stick. Better still, they can be kept within bounds by means of introducing water snails into the aquarium. Not only are they invaluable as " window cleaners," but their eggs often provide the fish with a much-appreciated change of diet.

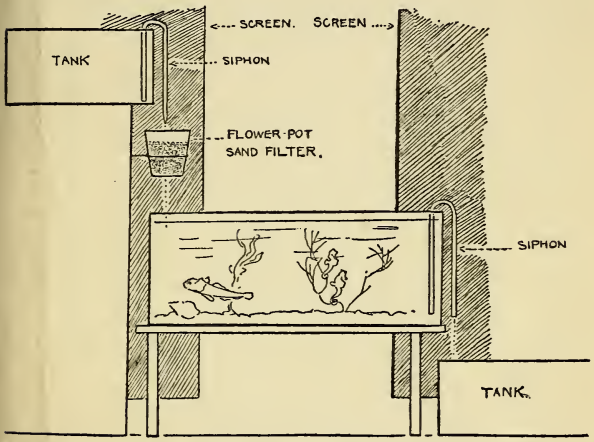
Of all the ills that fish are heir to, fungus, *Saprolegnia*, a bacterial disease, is the most widely disseminated. It shows itself in the form of a whitish or greyish film or furr which coats the outside of the fish, and which unless treated at the outset will attack the gills and cause its victim to die of asphyxiation.

The uninformed sometimes regard the presence of " fungus " in its initial stages as merely a sign of age, especially when noticed upon large carp, but it is undoubtedly a most virulent and highly infectious disease usually developed in aquaria by fish that have contracted a chill as a result of sudden changes in the water's temperature. It is often introduced through some newly acquired specimen, for which reason it is as

well to isolate all new additions to the aquarium for a short period, watching carefully for any signs of latent ill-health. If the "fungus" has firmly established itself upon a fish before it is detected, there is no hope of its recovery, and it should at once be removed,—and destroyed. Less serious cases may be checked in time by removing the fish to another comparatively dark vessel in water rendered brackish by the addition of common rock salt—a tablespoonful of salt to two gallons of water. Bathing the fish in weak solutions of permanganate of potash, copper sulphate, and ammonia, are other methods recommended, but the salt-water treatment is the safest and in my experience the most effective. A pinch of salt placed from time to time in the aquarium itself will do no harm, and will act as a check to any bacteria that may be present in the water.

The guiding principles to be observed in keeping a small fresh-water aquarium apply equally to one containing salt-water. Most animals inhabiting the sea, however, require more oxygen than those emanating from ponds or rivers, and it is best to circulate and filter the water on the principle of the large public aquarium. This may be effected by means of the simple apparatus shown opposite. A siphon empties the water from the tank A into the exhibition tank, and at the same time a second siphon runs off the water from the exhibition tank into the receptacle B. Thus a gentle but constant stream of water is caused to flow through

the tank. A flower-pot filled with sand may be employed to filter the water before returning to the exhibition tank, the water, after passing through the sand, dripping slowly into the aquarium. When the overflow tank B is full, the water it contains is emptied into tank A, and the operation is repeated at intervals. The



MINIATURE MARINE AQUARIUM, SHOWING HOW THE WATER MAY BE CIRCULATED ON THE PRINCIPLE OF THE LARGE PUBLIC AQUARIUM.

storage tank and the overflow tank should both be of equal capacity, and the aquarist will soon find that the flow of water can be controlled to last for twelve or more hours, according to the requirements of the inhabitants. With a little ingenuity the entire apparatus can be " camouflaged " so as in no way to detract from the beauty of the aquarium itself. In the con-

struction of the marine aquarium as little metal as possible should be made to come into contact with the water. Iron is the least harmful and can be used when coated or painted with enamel or bitumastic.

If the aquarist has any difficulty in obtaining water from the coast there is no reason why he should not "manufacture" his sea-water at home. The following formula has given satisfactory results :—

	oz.
Common salt	45½
Potassium chloride	1¼
Calcium chloride	2
Magnesium chloride (dry)	8¾
Magnesium sulphate	11½
Bicarbonate of soda	⅕

The above should be mixed with 10 gallons of soft water to which should be added—after mixing—⅕ oz. of potassium nitrate, 10 grains of sodium phosphate, 5 grains of chloride of iron ; and ½ a gallon of natural sea-water.

The reason for adding a small quantity of natural sea-water to that manufactured chemically lies in the fact that sea-water contains some mysterious ingredient which up to the present has defied analysis, but which may be considered analogous to what is known as the vitamins contained in food. Its entire absence would result in the animals developing disease in a comparatively short period of time. In addition to shading the aquarium from the direct rays of the sun and protecting the surface of the water from an accumulation

of dust, care must be exercised in keeping the water at the same level, or its salinity will by evaporation become too great. To obviate this, the level of the water may, when first introduced, be marked upon the glass front of the tank, and the slightest falling below this level be remedied by the introduction of pure fresh-water. A more scientific way, however, is from time to time to test the sea-water, which should have a strength of about 1·025, with a hydrometer. Sea-weeds should be introduced with extreme caution as they tend to foul the water and poison the inhabitants.

The carnage of the river-bed pales to nothing compared with that of the sea, and great vigilance must be exercised in the selection of tank-mates. Only amiably disposed animals should be associated, and such pugnacious creatures as large crabs and lobsters must be given private apartments in separate aquaria. All food not consumed should be removed or disposed of by scavengers such as prawns and very small crabs introduced for the purpose. But here again discretion must be used, for if small prawns are placed in a tank containing large anemones, the span of life of the former will be short.

To sum up, those who are really interested in aquarium-keeping will never tire of their hobby, for the wonders which the watery world daily unfold to the patient and enthusiastic aquarist repay with compound interest the labour and trouble involved.

When fairly established an aquarium can be made

to hold the mirror up to " nature " in a way scarcely possible with any other form of zoological collection. Each tank at Regent's Park, for instance, shows a group of animals in natural surroundings. It is easier to bring a piece of a coral reef to the Zoo, the better to make a turtle look and feel at home, than it is to provide an elephant or a baboon with its native atmosphere.

To mingle with the crowd of visitors thronging the corridors of the Zoo Aquarium is to realize what a revelation it is to most people, and how varied are the ways of enjoying it. The appeal that the aquarium makes to scientists of every grade and description, to artists and fishermen, may be readily understood. A few folk, however, view the tanks and their contents from the strangest angles. An elderly, much-travelled general, a hero of the Great War, who I had the honour of conducting round the institution, saw in each fish merely the happy memory of some past meal. At each tank he would inquire—are those fish edible ? If my reply was in the affirmative some minutes would be spent contemplating the inhabitants ; if, however, I answered in the negative, we just passed on to the next. His enjoyment was of a purely gastronomical nature. The fact that the fish were not sea-sick was what was of supermost interest to the Llamas, the holy men of the mountains of Tibet, who during a recent visit to this country spent a whole morning in the aquarium. The visitor, however, who gave us the greatest shock was a lady who arrived late one afternoon carrying an

enormous carpet-bag. She went straight up to a keeper, and inquired at what time the fish were sold. It appears that she had been informed that all the exhibits were changed daily and sold by auction at closing time! The above examples are, however, isolated ones and the majority of visitors take an intelligent interest in what they see. The aquarium is a wonderful educational factor, and facts about our aquatic fauna which at one time were only known to a few specialists are now becoming common knowledge. The aquarium is further a means of clearing up many points of scientific as well as national importance. The feeding habits of our food-fishes, their multiplication, individual growth, diseases, and enemies are all vital matters which come within its scope.

PART I

THE SEA-WATER AQUARIUM

CHAPTER I

INVERTEBRATES

THE Invertebrates need little introduction, for they force themselves upon our notice at every turn of life. Those that are terrestrial are so abundant, invading on occasions even our homes, that to ignore them is impossible. But numerous as they are, their numbers become insignificant when compared with the uncountable legions of backboneless animals infesting the waters, both salt and fresh. They fill the seas with their freely swimming hordes, covering every rock and weed with a bewildering array of sedentary forms; they mimic the branches of trees and shrubs of the air-breathing world, and compose great deposits of solid rock, strong enough to bear the habitations of man. They are as abundant at the frozen poles as in the tropics, and once held undisputed possession of the world at large. The more complex invertebrates of to-day form interesting links between the first beginnings of life and the dawn of the vertebrated animals whose progressive development culminated in the advent of man.

To systematically review the invertebrates, even those confined to our own waters, would demand a

vast library. In the present chapter, therefore, it is proposed merely to dwell upon those forms which by their size, remarkable habits, or economic importance, at once commend themselves to the notice of the aquarium visitor.

THE PROTOZOA.—These minute creatures constitute the very simplest forms of animal life. They swarm in all waters, and although the visitor to the aquarium will not find them labelled or figuring in the official guide, he may be confident that every tank he passes contains them, not by hundreds or even thousands, but by incalculable millions. Each individual creature consists of a single cell, provided with a little whip or "flagellum," with which it propels itself through the water. One common marine species is visible to the naked eye, and occurs in vast numbers. It is called the "night-light" or *noctiluca*, and when present in great quantities contributes largely to the "phosphorescence" which sometimes illuminates the waves at night.

Many species of *Protozoa* form tiny shells composed of carbonate of lime, and present an endless variety of forms. These shells, being deposited layer upon layer, build up in the course of ages the great chalk deposits so common in many parts of the world.

The SPONGES, *Porifera*, attain to dimensions which render them conspicuous. The members of the

group differ from the Protozoa in that they have a body cavity supported by a horny or calcareous skeleton. The dead skeletons of some of the largest forms, such as the bath sponges of commerce, are often introduced with good effect as settings in the tropical tanks of large aquaria. Many of the smaller, native species can be exhibited alive, being either introduced attached to rocks and shells, or appearing voluntarily from spores floating in the water.

A sponge begins life as a tiny free-swimming animal propelling itself along by means of the numerous fine hairs which incessantly beat the water. Presently it settles down upon a rock or other solid foundation, and there builds around itself a horny rampart composed of minute spicules of mineral substance extracted from the sea-water. When many millions of young sponges are thus fortified and living *en bloc*, one can well picture to oneself the true nature of a sponge. It may be likened to a series of under-water tenements, the walls of which are pierced with innumerable holes and canals to permit the free circulation of the water, and so ensure the health of the community. The constant circulation is maintained by each individual animal lashing the water with a minute whip, and the currents thus maintained are clearly visible if the water containing a living sponge be tinted with some colouring matter.

The beautiful little yellow Flask Sponge, *Sycon compressum*, found on seaweed, and the red and orange

Bread Crumb Sponge, *Halichondria panicea*, that encrusts the rocks are the commonest native species, suitable for the aquarium. They have their practical uses in the tanks, serving as natural filters and extracting much organic matter from the water. Many molluscs and echinoderms feast upon them, and a number of creatures rely upon sponges for shelter, or as an aid to render themselves inconspicuous. The Fig Sponge, *Ficulina ficus*, has a habit of covering the shells inhabited by hermit crabs, both crab and sponge benefiting by this co-partnership, the former enjoying the " camouflage " afforded by the latter, which shares the hermit's meals with him. The quaint sponge crab, *Dromia vulgaris*, always carries a sponge, *Cliona*, upon his back, holding it in position with a pair of legs specially adapted for the purpose. The sponge in question is a harmful one as it plays great havoc in the oyster beds, perforating the shells of the molluscs and so rendering them easy preys to their many other foes. To prevent this oysters are frequently grown in frames which can be drawn up and exposed to the rain, a procedure harmless to the oyster, but fatal to the sponge.

The Polyps, *Cœlenterata*, are animals with hollow interiors and are represented round our coasts by the Jelly-fishes, Sea-anemones, and Corals. At a first glance these varied forms may not appear to have much in common, but a closer examination reveals

their kinship, and shows them to be built in the main upon the same general principles. A single cœlenterate is termed a polyp, which consists of a sack-like body having a central stomach, and the sack is either anchored to a rock or shell, or to a fellow-polyp. The upper extremity of the body is furnished with a number of tentacles which gather food and pass it into the interior. There is no special outlet for waste matter as in the higher invertebrates, the " left over " portions of a meal being simply ejected through the mouth. These animals multiply by one of three methods. They may " bud off " from each other in the manner of bulbs ; they may lay eggs ; or they may increase by the method known as the " alternation of generations," which briefly amounts to this. A single polyp gives rise by the process of budding to a branching colony of polyps. In due season certain of the buds detach themselves and lay eggs, which hatch out into free-swimming larvæ. These in their turn settle down, develop into polyps and by budding off, once more create a colony. Nature's recurring decimal !

Jelly-Fishes are very delicate creatures, and rarely figure in the aquarium for long. Usually the animal is supported by an umbrella-shaped disc which by contracting and expanding propels it through the water. Sometimes, however, the disc may take the form of a boat with an inflated cockscomb which serves the double purpose of a buoy, and a sail to catch each passing breeze. The stinging, reproductive, and

feeding organs depend from the umbrella or float, and act as drag ropes to prevent the animals drifting too rapidly. Sometimes jelly-fishes occur in vast swarms, sufficiently dense to bar the passage of a comparatively large vessel, and may be blown ashore after a gale until they cover many acres of beach.

The largest jelly-fish found in Northern latitudes is *Rhizostoma pulmo*, which may measure several feet across the "umbrella," and weigh nearly one hundred pounds—a hundred pounds of water, for the animal is 98 per cent. fluid.

A beautiful chance visitor is the Portuguese Man-of-War, *Physalia arethusa*, a form supported by a "float," both the float and its dependent streamers being most gorgeously tinted with all the colours of the rainbow. It is very abundant in tropical and sub-tropical waters, where it is justly dreaded, having stinging powers far beyond those of any of its congeners. Human beings involved in its filaments suffer severely for many days or even weeks, whilst the sting immediately proves fatal to most fishes. In spite of its stinging powers, several kind of sea-snails and most turtles will attack and demolish this jelly-fish with impunity, the latter, however, always taking the precaution of shutting their eyes when going into action. The Man-of-War has been shown alive for a few days in the New York, Naples and Plymouth aquaria.

The beautiful ANEMONES which decorate every tidal pool are perhaps the most readily studied of all

the Cœlenterates. They are polyps on a grand scale, but although their methods of feeding and reproduction may be observed with the naked eye, it is often difficult to persuade the ordinary aquarium visitor that they are not the counterpart of terrestrial flowers. Their tentacles are often highly charged with stinging cells, as indeed are their entire bodies, and when irritated most species throw out from their graceful columns masses of stinging threads, which look like so much cotton. Like all polyps, anemones are distended with water, and when disturbed can, by expelling the water from their numerous pores, contract until they are mere blobs of jelly. Though apparently as well rooted as any flower may be, they are capable of gliding on their bases over the rocks or glass of their aquarium.

The majority anchor themselves in fairly exposed situations, but others affix themselves to stones or shells hidden several inches below the sand. Only the brightly hued tentacles of these protrude above the sea-bed, and the shrimp that attempts to flit across them is checked in his stride, and disappears from view for ever. Having been assimilated, the indigestible portions, such as the shell, are eventually vomited forth. Should the anemone suffer from indigestion, or object to some quality in the surrounding water, it may protrude the whole of its stomach, which resembles a fluted glass bulb, and by turning it inside out make a clean sweep of everything, a faculty which the dyspeptic may be inclined to envy.

Anemones are greedy creatures, a specimen only 2 inches in diameter having been observed to swallow a scallop the size of an ordinary saucer. As a consequence all communication between the lower portion of its stomach and its mouth was cut off. It, however, solved the difficulty by opening a new mouth at the base of its body. After this *tour de force* it was able to gratify its voracious appetite by taking two meals at once. Another specimen kept by an acquaintance of mine swallowed his latch-key which he had inadvertently dropped into the aquarium. Nearly a week elapsed before the attempt to digest the unsatisfactory meal was given up and the key ejected.

Several species of anemone may be recommended to the aquarist. The Beadlet or "Strawberry," *Actinia mesembryanthemum*, is one of the commonest of species, and abounds on every shore from Penzance to the Orkneys. In colour it varies from emerald and olive green to deep brown, red, or crimson and may be covered with golden spots, when it resembles a strawberry.

The Plumose Anemone, *Actinoloba dianthus*, is a tall graceful form having many hundreds of finely cut tentacles, so closely packed that they recall a finely curled ostrich feather. The colour varieties of the Dahlia, *Tealia crassicornis*, one of the most beautiful of all anemones found in European waters, would outrun the longest florist's catalogue. It grows to a length of 7 inches across the tentacles, such specimens

THE ANEMONE TANK.

Anemones :—Plumose, Dahlia, Opelet, Strawberry and Parasitic on Hermit Crab's shell. Feathery Tute-worm in foreground. Sea-Fan Coral in background.

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having a column 4 inches in height. The stem is rough and warty and is provided with adhesive suckers which readily adhere to scraps of shell and gravel, thus effectually concealing the animal. The anemone is, however, often situated in large numbers on a rocky site where it is rendered conspicuous, and holiday-makers in certain parts of the Mediterranean make pleasure trips in glass-bottomed vessels to such localities, and feast their eyes on the great Dahlia beds which carpet the floor of the ocean. The Dahlia has a large appetite and after a prolonged fast will devour such large creatures as shore crabs, hermit crabs in whelk shells, small fish and even fellow-anemones.

Few CORALS thrive in an aquarium, but the hard limy skeletons of some of the reef-building forms are suitable for decorating tropical tanks, and large masses are shown at the Zoo Aquarium where they form a picturesque and fitting background to such creatures as turtles and coral fishes. They are the nearest that most of us will ever get to the glories of the barrier reef. In life these huge white tree-like structures are clothed in dazzling tints of orange, pink, green and gold as each small polyp thrusts himself half out of his stony castle.

Our native Sea Fan, *Gorgonia verrucosa*, is a shrub-like form of soft coral of a brilliant pink or orange tint and grows to a considerable size. The polyps are built up on a black horny core or axis, which when denuded of the animals and washed ashore is often

mistaken for a dead bush. It thrives for some months in the aquarium.

The Dead Man's Fingers, *Alcyonium digitalum*, is a flexible coral, very abundant around our shores where it is to be found attached to stones and shells. When alive it is cylindrical in form, making large clumps of pinkish " fingers " from which protrude innumerable transparent polyps. When dead the fingers become flabby and grey in colour,—hence its gruesome popular name.

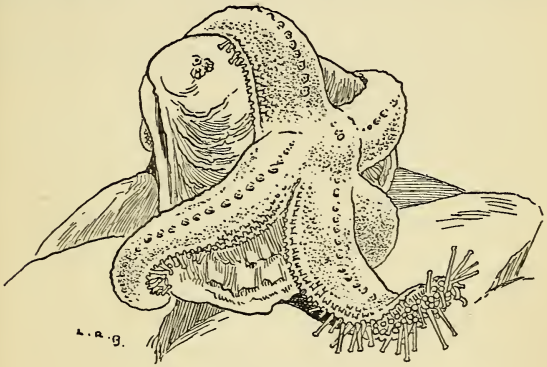
ECHINODERMS are divided into three groups, sharply contrasted as to their outward shape, yet all mere variations of the same general theme. They comprise the Starfishes, the Sea Urchins, and the Sea Cucumbers, and, as their scientific name implies, they are all animals with spiny skins. They are, without exception, marine, for the reason that fresh-water does not contain sufficient mineral matter for the construction of their tough calcareous coats. Echinoderms come of an ancient lineage, for they had their beginnings when the world was young, and in those far-distant days they sometimes attained gigantic proportions. Over this country there once rolled a vast ocean in whose depths dwelt enormous starfishes having a spread of " finger " that would outspan the largest round table ever constructed. To-day the degenerate descendants of this mighty race swarm upon the sands and fill every convenient rock-cranny with a multitude

of fantastic shapes, yet all built upon the same fundamental principles. Let us take as an example a typical starfish. It is an animal having the body usually divided into five rays or arms, which are built up on a siliceous or limy framework. In some Echinoderms the various portions of the frame may coalesce so that they form one continuous structure of jointed armour plating, but in others such as the common starfish the skeleton is covered with a leathery skin. The rays of the starfish which may be divided and subdivided and subdivided yet again, meet at a point so inconsiderable that it can scarcely be called a body. As a result various organs of the animal are portioned out in equal sections, and accommodated in the arms. The creature is the possessor of a central mouth, a separate opening for the ejection of waste matter, a comparatively well-formed intestine, and a fairly efficient nervous system. They are of nomadic temperament, and are able to indulge their taste for a wandering life by being fitted with a wonderful apparatus termed the " water vascular system." By means of this system they are propelled by hydraulic power. Watch a starfish that happens to be " spreadeagled " on the glass front of an aquarium, and it will be observed that the under-surface of the animal is set with hundreds of small and semi-transparent tubes, each of which is provided at its tip with a little circular sucking-disc. A number of these tubular feet take a firm hold of the glass, and drag the creature forward.

The " feet " in the rank immediately behind do likewise, and they in their turn are followed by yet another series—and so the starfish progresses with an insidious gliding movement, wonderful to behold. The inner workings of this at first sight complex apparatus are in reality beautifully simple. The central mouth is surrounded by a circular tube from which radiate other tubes penetrating the arms to their tips, and they are connected to yet another series made of hard, limy substance, and called the " stone canal " which is in its turn connected to a series of hairs. These hairs by continual vibration fill first the stone canal, and then the flexible water pipes controlling the suckers or tube feet. As the water is forced into them they become stiff and inflated, shooting out in whatever direction the animal desires, and mechanically attaching themselves to whatever they may encounter. Having taken a firm hold the water is shut off from them, and other tubes become inflated in their turn. So the starfish goes marching on. When he tires and progression is no longer desired the engines or vibratory hairs are simply closed down, and the animal comes to rest.

Like many invertebrates, and a few vertebrates, starfishes have the power of regenerating lost parts. Thus if a single arm be torn from a starfish, it will grow one or more arms to bring itself up to full strength. This power of reproducing lost limbs at one time gave rise to a ludicrous and even disastrous state of affairs on the oyster beds. The oyster fishermen dredged up,

—as they still do—enormous quantities of starfish. Now the starfish being the oyster's worst foe, what must the men do therefore, but tear the hated creatures into pieces and fling them back into the sea where they speedily repaired themselves, each piece becoming in time a perfect starfish ready to play a return match with their persecutors. Millions of starfish were thus dealt with and as a result thousands of pounds lost



THE STARFISH.

to the oyster-farmers. The men know better nowadays, the starfish being taken ashore and placed by the cartload on the land where they make a splendid fertilizer.

Starfish will eat almost any kind of flesh, clearing the bait from the lines and even invading lobster pots. They are specially fond of shellfish, which they clasp in their arms. To open an oyster or a scallop the

many hundreds of suckers tug and strain as one, the total pull exerted having been calculated at as much as 11 lb.

Although of little nutritive value the starfish is eaten by a number of large fish. As he is also infested with numerous parasitic worms and molluscs he does not have things entirely his own way.

Starfishes begin life within a minute transparent egg, and are tiny free-swimming larvæ when they hatch out. They then resemble little glass balls which ferry themselves through the water by means of innumerable lashing hairs.

Two species of British starfish may be kept for some months at a time in the aquarium. They are the Common Starfish, *Asterias rubens*, which lives in both deep and shallow water, and is so frequently stranded by the tide, and the Burrowing Starfish, *Astropecten irregularis*, which frequents chiefly shallow water where it does much damage in the oyster beds, and may be differentiated by the spines which clothe its surface which are so tightly packed as to form an almost velvety cuticle. Like the common form it is very active, and if turned upon its back will quickly right itself by arching its rays, and throwing a somersault. Although quite abundant on the south coast it is less in evidence than *Asterias* owing to its habit of burrowing in the sand.

The largest species of Starfish, *Luidia sarsi*, which may measure 2½ feet across the arms, can unfortunately

not be obtained for aquaria as it is so brittle that it immediately breaks into pieces on being touched.

One or two of the true Brittle Stars, however, in which the slender rays are set with innumerable spines, can be kept in captivity for short periods. They are remarkable in gliding spider-like over the sea-bed and parting with their limbs upon the slightest provocation.

The Sand Stars are similar in design, but have the arms encased in smooth armour, quite devoid of spines. In a very lovely form known as the Rosey Feather Star, *Antedon bifida*, each of its ten arms is beset with delicate plume-like branches that remind one of ostrich feathers dyed a vivid rose colour. Most animals tend to " throw back " or at least to recall their early ancestors during the first stages in their development. This is noticeably the case with the Feather Star which begins life as a free-swimming larva. Presently it becomes fixed and grows upon a stalk anchored to a rock in the manner of its forbears—the crinoids, now almost extinct, but which at one time had a world-wide distribution and attained to a great size. In time the Feather Star breaks away from the stalk and once more becomes a rover, in which capacity it spends the remainder of its life.

The Sea Urchins may not at first sight appear to have much in common with Starfishes. Imagine, however, a starfish in which the five arms have been turned backwards until their tips meet, and the points and edges united with the tube feet pointing outwards.

Thus a sea urchin is produced. Like starfishes, sea urchins are active and voracious creatures, some burrowing in the sand, others climbing rocks or patrolling gravel reaches. The only species that survives for any length of time in aquaria is the little Purple-tipped Urchin, *Echinus miliaris*, a pretty creature the shape and size of a tangerine, and protected by a dense covering of dark green spines with delicate lilac points. Although similar to the starfishes in most of their ways, this and many other sea urchins have undergone some curious modifications in structure, necessitated by their globular shape. Each spine is set in a ball and socket joint, so that they " give " when the tube feet are employed in climbing rocks, or the glass front of a tank, and serve to maintain the creature's equilibrium. The mouth in most sea urchins as in all starfishes is central, although in the sand-burrowing Heart Urchin, *Echinocardium cordatum*, which has soft, yellow, silky spines, it is situated on one side. A typical urchin's mouth is a most complex structure, consisting of many portions and possessing five strong chisel-like teeth which are employed for cutting up its food. This remarkable appliance attracted the attention of Aristotle, the father of natural history, and is to this day commonly referred to as "Aristotle's Lantern."

The Edible Urchin or Sea Egg, *Echinus esculentus*, is a common British species. Although seldom used for food in this country it is in great demand in certain parts of the continent where, having been denuded

of its spines, it is cut open and eaten with a spoon.

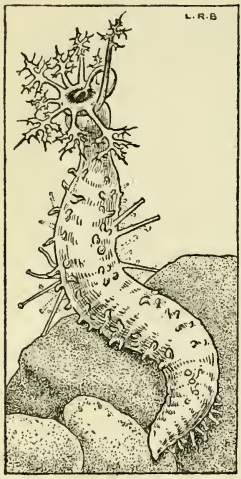
The Sea Cucumbers, so called from their shape, are built on the same pentagonal plan as are the starfish and sea urchins, but are fashioned for a less obtrusive life, being of decidedly furtive habits. Burrowing deeply in the sand or mud, or squeezing into the fissures of rocks, as is their custom, they would be impeded by the possession of so unyielding an armour as that of the sea urchin, whilst the stiff-jointed cuticle of the starfish would be almost equally unsuitable. Sea cucumbers are therefore lax and fleshy and capable of great expansion and compression. One species, the Trepany or Bêche-de-Mer of the tropical seas, is made the object of an important fishery, and off the great Barrier Reefs are collected in their thousands by the natives, who, after having taken them ashore, clean, dry, boil and finally smoke them. They are served in a number of Chinese restaurants in London, but are not found palatable as a rule by Europeans, on first acquaintance, the taste for them being a decidedly cultivated one. It is, however, an extraordinary important fishery, meaning much to the Orientals, and is fraught with as much danger and romance as attends the gathering of pearls.

The tube feet of the sea cucumber are arranged in five irregular rows along the body which may vary in length from 2 inches to 3 feet according to the species.

The Sea Gherkin, *Cucumaria saxicola*, is an elegant little creature with usually a milk-white body and

purple tentacles, specimens from shallow water being darker in colour. It is very abundant off our coasts and will live for many months in a quite small aquarium.

The Cotton Spinner, *Holothuria nigra*, is the giant of its race,—in British waters, often exceeding a foot in length, and having a girth of at least 9 inches. It is deep brown above, sulphur yellow below. Its method of defence is noteworthy, for the creature upon being molested will eject a vast quantity of sticky threads, which immediately swell on exposure to the outer water and form an entanglement from which a fish or crab seldom escapes.



COTTON SPINNER.

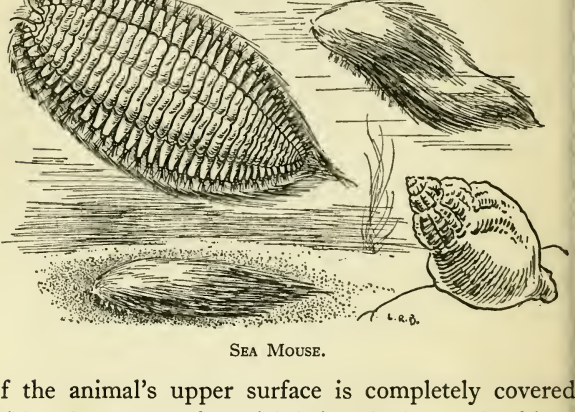
WORMS.—"Worm" suggests something unpleasant—a creature not to be touched with the naked hand, and as a term of disparagement has no equal. This is hard on the land worm, for he does much good by turning up the soil and cleansing it of many impurities. But his outward appearance is against him, and this, combined with the fact that he shuns the light of day and does his good work unostentatiously underground,

is sufficient to condemn him in the eyes of the majority of people. In the aquarium, however, we meet creatures which invest the word " worm " with an altogether new significance. Some swim like fish, shine with silvery scales and are clothed with coats of prismatic hairs, rivalling in colour the gayest butterflies and birds. Others coyly hide their personal charms in graceful tubes of sand, gravel or scraps of brightly tinted shells. Many are of a retiring disposition and hard to find, but quite a number of tube-builders congregate in such quantities that their high-piled tenements form reefs and little islets in the sea. Frequently these creatures have spoilt a vessel's speed record by so clogging her keel with their lime-built fortresses that she has had to be docked on returning home from her voyage. The sea is full of fantastic and fascinating creatures which although they disguise their true natures, scientifically speaking, answer to the name of " worm."

Worms are abundant in every sea, and our own shores provide many hundreds of species. Unfortunately they seldom accommodate themselves to the confined area of an aquarium. A few very showy examples may be kept alive for comparatively lengthy periods, and to such we invite the reader's attention.

A very striking worm is known as the Sea Mouse, *Aphrodite aculeata*, which is about 7 inches long by $2\frac{1}{2}$ across, and is quite the bulkiest member of the order to which it belongs. It is one of the *Polychæta*,

or " many-footed " worms, the body being divided into forty-three segments, each provided with a pair of feet surrounded by bristles. It is the possessor of a definite head with a brain, eyes, antennæ, and a mobile proboscis or snout which can be extended some distance for the purpose of seizing food. The whole



Sea Mouse.

of the animal's upper surface is completely covered with a dense coat of greyish hairs, the long hairs fringing the sides displaying an amazing series of iridescent colours, dazzling in their brilliance ; whilst the hairy coat serves to collect sand and thus renders the sea mouse inconspicuous, many fish rout him out of the sand and devour him greedily.

The common Rag Worm, *Nereis diversicolor*, a graceful creature gleaming with rainbow tints, is familiar to all who have done any sea-fishing.

It burrows in the sand or mud, and when extracted for the purpose of bait does not hesitate to use its powerful jaws upon the fingers of its captor. As with many polychæte worms its methods of reproduction are very peculiar. The hinder portion of its body develops a large number of eggs, and this breaking off from the main portion, develops a head and becomes a separate individual. This extraordinary procedure has a number of strange variations amongst different kinds of worms, in some cases the egg-bearing portion developing a head before separation.

The Hermit Crab Worm, *Nereis fuscata*, is specially remarkable in always being found in conjunction with a hermit crab, which tenants the empty shells of whelks and winkles. The worm lives in the spire of the shell, and relies for sustenance upon sharing such food as the crab happens to find. As the latter believes in good food and plenty of it, it does itself well. The life of the worm is indeed an easy one, for resting in the upper portion of the shell it only becomes active when there are unmistakable signs of a meal being served, when the lodger bestirs itself and comes down to dinner. It is a curious friendship, for the hermit lives at enmity with most creatures, and yet never seems to resent the presence of the worm, or to offer it the slightest opposition even at feeding time. The worm, which grows to a length of 6 inches, is of a deep terra-cotta colour with vivid white lines running throughout its entire length.

The worms which may be relied upon to make the finest exhibition in the aquarium are those known as "tube-builders."

The Peacock Worm, *Sabella pavonina*, is a typical example, and its cylindrical homes may be seen sticking out of the sand in very large numbers, the foot-long tubes projecting several inches, when the sandy area inhabited by these creatures resembles a field of stubble. When, however, the worms inhabiting the tubes are "in action" the stubble field becomes transformed into a miniature palm-grove, for each worm is provided with a large coloured, fan-shaped crown of gill-plumes, which serve not only to gather food, but also to play an important part in the building of the tube. The plumes gather portions of the surrounding sand or mud, and pass them on to the mouth, which places them layer upon layer on the upper edge of the tube, much in the manner that a bricklayer might build a round tower. Some of these tube-builders use coarse material such as shell gravel, and in aquaria they may be supplied with coloured beads, the resultant tube having a distinctly striking appearance. These worms are extremely cautious, and retire into their fortresses upon the slightest cause for alarm, such as a shadow falling across them. Many close the tube with a sort of trap-door, or a series of valves, which effectually prevent the ingress of any chance caller. They are further provided with a series of stiff bristles and hooks which render it impossible to drag them from their castle.

Spirorbis borealis of our coast makes a small flat coiled tube about $\frac{1}{8}$ of an inch in diameter formed of small pieces of rocks and shells, and the larger seaweeds are often densely studded with this worm. Apart from being extremely active, it is less subject to " nerves " than some of its relatives, so that its plumes and other features are more easily studied.

An impressive tube-builder, and one that thrives specially well in the aquarium, is the large Feathery Sea-Worm, *Spirographis spalanzoni*, which inhabits the Bay of Biscay and the Mediterranean. The large feathery plumes, which are coloured orange with chestnut-brown markings, wave about at the end of a long slender stalk and remind one more of chrysanthemums than worms.

A ribbon worm, *Lineus longissimus*, popularly known as the Bootlace Worm, is occasionally kept for short periods in aquaria. When quiescent it resembles nothing so much as a mass of liver, but when active may extend itself to a length of 90 feet. Its habit is to lie concealed beneath an overhanging rock, and upon the approach of a fish to shoot forth a sucker-like mouth which seizes upon the unsuspecting prey. The fish naturally makes desperate efforts to escape, but it is being " played " with a living fishing-line which follows all its movements without losing grip, until finally the exhausted creature is overpowered and engulfed. The creature is very brittle and readily breaks up into innumerable fragments, all of which are capable of

growing new heads and tails, and ultimately becoming a fully-grown worm.

The CRUSTACEA contribute to man's food supply either directly, as in the case of the crab and lobster, or indirectly by constituting an important item in the diet of our food-fishes. They are omnipresent, and it may be safely asserted that for each showy specimen that attracts the visitor's attention in the aquarium, there are countless hosts of minute forms sharing the same tank which are invisible to the naked eye, save when they are present in such numbers as to actually discolour the water.

Whilst at times bearing superficial resemblances to their relatives the insects, the spiders and the scorpions, the crustaceans present many characteristics which make them at once distinguishable. Primarily there is the shell or crust which gives the order its name. This shell usually envelops the animal from head to tail, but is thinned out in places, so as to be almost membranous, thus forming the joints which permit of free movement. It is quite hard and unyielding, and must be changed from time to time in order to permit the animal within to increase in bulk. Many crustaceans when first hatched are quite unlike the adult form and pass through some startling changes before arriving at maturity. Some, however, like the lobster and sand-hopper, are almost miniature replicas of their parents as soon as they hatch from the egg. Another

typical feature is the body, for it is divided into a number of segments, each bearing a pair of limbs or " appendages " which are not uniform in size or shape like those of a centipede, but are situated on different portions of the body and are modified to serve a variety of purposes. These appendages may be drawn out into long filaments and employed as probes or organs of touch, serrated to do the work of teeth, flattened to perform the office of shovels or paddles, strongly hooked and used as climbing irons, or so constructed as to form formidable forceps and tweezers. In the aquarium crustaceans make the most fascinating exhibits, as they attract attention not only by their strange forms, but also by their restless energy and entertaining habits.

The Common Lobster, *Homarus vulgaris*, has usually a blue-black armour, deep-water specimens being darker than those found in the shallows ; sky blue, brown and even scarlet varieties, however, are not very uncommon. The animal is provided with a head, thorax, and tail, which are divided into a number of segments, and twenty pairs of appendages—one pair on which the eyes are mounted, two pairs forming antennæ, three pairs forming jaws, three pairs known as foot-jaws and which serve the dual purpose of breaking up the food and circulating the water in the neighbourhood of the gills, five pairs used for progression, the first of these forming the claws, and six pairs situated under the tail and known as swimmerets. The

two claws differ in size. The larger one is blunt on its inner side and is used for crushing the shells of its prey, whilst in the smaller claw the inner edges are sharp and employed for cutting purposes.

The eggs, up to 80,000 in number, are fastened to the undersurface of the tail, and are aerated by the incessant flapping of the swimmerets. The lobster is a born fighter and constantly engages in conflict with his tank companions, sometimes losing his life, or at the best several limbs. Therefore, anybody well acquainted with this crustacean in his unboiled condition must be surprised at the " drawing-room " appearance of the Zoo specimens. There are no claws or limbs missing —or none to speak of—and no feelers snapped in half. The explanation of the apparently exemplary conduct of these lobsters lies in the fact that they do their hardest fighting at night, and the " second bests " are removed to reserve tanks in the morning, where after casting their shells they speedily recuperate and grow fresh claws, antennæ, or other items lost in the course of their night out. The gaps in the lobster ranks are filled by waiting understudies, and by the time these are injured the original lot are usually in a fit condition to appear again before the public.

Damage to claws and other limbs often gives rise to curious monstrosities, a cast crushing claw, for instance, being sometimes replaced by one fashioned for cutting purposes.

When the time is ripe for the lobster to moult, the

creature loses its usually ravenous appetite, and retiring into some snug retreat awaits the great change. This is heralded by his old armour cracking at the juncture between the thorax and the abdomen. In the crab the method is quite simple, for the shell splits at the seams upon its lower surface, the upper portion lifting off like a dish-cover. The lobster, however, has a hard struggle. Bit by bit, with many pauses to rally its energies, the animal extracts every portion of his soft and pliant body from the old armour, every particle being cast, even to the eye-lenses, gills and stomach lining. The lobster comes through the ordeal weak, helpless, and with a soft body, and when in this hapless condition is often attacked, not only by his companions but by such normally pusillanimous creatures as shrimps and prawns. In the aquarium, when about to " cast," the lobsters instinctively feel helpless, and at the Zoo take shelter in holes in the rockwork which have been provided for them for that purpose. If, however, they are spotted to be in the act, no risks are taken, and they are immediately removed to the reserve tanks. Sometimes they have to be helped in the process, just as the snakes in the reptile house have at times to be assisted in shedding their " skins."

The new carapace, which is always slowly forming beneath the suit actually in use, hardens after four or five days' exposure to the water, the lobster often helping in the stiffening process by making a meal of his old clothes. Under favourable conditions the lobster

may attain to a weight of from eight to twelve pounds, and live for twenty years, such veterans usually being found encrusted with barnacles and other sedentary creatures,—a sure sign that the shell has not been cast for some considerable time. A lobster of this age and size is a very powerful creature, and has few enemies apart from the all-devouring conger, wolf-fish, and octopus.

The lobster is subject to an amusing experiment. It will be found that by stroking it in a certain direction a coma is produced, so that it remains perfectly still, when it can be made to rest tail-upwards, standing on its " beak " and outstretched claws. The coma is quite transitory, and the animal so imposed upon usually comes to more bellicose than ever.

Another popular long-tailed crustacean is the large orange or yellow Craw-Fish or Rock-Lobster, *Palinurus vulgaris*. Like most crustaceans it is hatched from an egg,—one of many thousands, carried upon the under-surface of the tail. But whereas the lobster hatches out with a strong " family likeness," the little crawfish differs so markedly from its parent that when first discovered it was assigned to a separate species. The adult crawfish is an entertaining creature, and shares the lobster's habit of burying scraps of food against a rainy day. At the Zoo these crustaceans soon learn to climb to the top of their tank, where they take food from their keeper's hand. Though lacking the lobster's massive pincers, they show great dexterity in

THE CRAWFISH TANK.

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opening shell-fish. They further evince a certain amount of musical talent, for by rubbing the basal joints of their immense antennæ against the sides of their beaks, they are able to produce loud grating sounds, not unlike a beginner's effort on the double bass. Their reason for producing this noise has not been satisfactorily explained.

The antennæ, so noticeable in all the members of the lobster tribe, are more than simple organs of touch. At the base of each is a tiny cavity, containing a few grains of sand, and investigations have proved that these serve to maintain the creature's sense of balance, corresponding to the semicircular canal of the human ear. Further certain hairs fringing the antennæ, and some of the other limbs, are provided with nerves which are in immediate connection with the creature's brain. These are termed " auditory hairs," and it is believed that they serve not only to transmit messages by vibration, but to pick up sound waves in the surrounding water. If this is so, they have anticipated the latest marvel of this progressive age.

The Flat Lobster, *Scyllarus arctus*, is a strange form which is very common in the Mediterranean, where it is used for food. Its short shovel-shaped antennæ are used for defensive purposes, and for burrowing, and concealing food whilst in the act of feeding. In striking contrast to this sluggish animal is the Common Prawn, *Leander serratus*, which is so transparent that its internal economy is clearly visible through its shell,

thereby differing markedly from the Shrimp, *Crangon vulgaris*, which is richly mottled.

Crabs and lobsters sometimes journey to the Zoo aquarium packed in damp seaweed, a form of travelling which if protracted for more than twelve hours results in the crustaceans arriving in a very feeble state of health. If immediately on arrival they were placed in deep water they would drown, their bodies having become filled with air *en route*. To obviate this, as they are unpacked they are laid upon their backs in quite shallow tanks, filled with just enough water to partially cover them. In these they recline and " bubble " out the air until their gills are once more filled with the life-giving salt-water, the patients being considered " fit " when able to struggle to their feet and turn over without assistance.

The crabs, of which there are many thousands of species, all begin life as tiny shrimp-like creatures which swim freely on the surface of the water. They change their shells frequently, and pass through several stages of development before attaining the parent form. When this is reached they tuck their tails beneath them, adapting themselves for a life to be spent in rock crannies or beneath the sand.

The Common Hermit Crab, *Eupagurus bernhardus*, starts life in the usual manner, but upon taking to the sea-bed is at once faced with a housing problem. His abdominal region is practically devoid of armour, and in a world of foes demands instant protection. He

COMMON HERMIT CRAB CHANGING SHELLS.

therefore tucks himself into the empty shell of a whelk, winkle or other gastropod mollusc. If he cannot find an empty shell to his liking he ejects the original tenant, and gains a dinner and a castle simultaneously. His

whole life is spent in one long fight for food and residence. Every time he changes his armour and increases in size he is confronted with the search for a home, for the former shell is now too tight to be comfortable. Shells are not made to measure, and the hermit must sometimes examine scores, probing their housing capacities with his legs and claws before finding the "ideal home." Hermit crabs are prolific animals, and the empty shell supply is seldom in excess of the demand. Furious battles are consequently fought for the possession of a home, and even when the victor is ensconced, and the doorway blocked with his large right claw, the victory is not necessarily won, as the fight will be continued unless the ejected crab has been completely "knocked out."

A remarkable feature of these crabs is the partnership which exists between them and a large anemone, *Adamsia polypus*, the latter invariably attaching itself to a shell inhabited by a hermit crab. Although sharing the crab's food the anemone is deliberately encouraged by its host for the protection it affords. A cod, for instance, will not hesitate to engulf a large hermit crab, whelk-shell and all, but thinks better of it when the shell is ornamented with two large anemones, which are not only very unpalatable, but render themselves highly noxious by waving masses of stinging tentacles and by throwing out stinging threads. In the course of time these anemones dissolve away the shell with the result that the hermit may spend his declining days in

an expansive cloak of anemones. His housing-problem troubles are then over.

Crabs vary very much in form. Some, such as the Masked Crab, *Corystes cassivelaunus*, are built for a life spent buried in the sand, taking in the sea-water through a pair of " feelers " which unite to form a tube down which the water is carried to the gills. Others known as Swimming Crabs have the hind feet flattened into paddles with which they take graceful swallow-like " flights " through the water.

Very popular with the visitors to the Zoo aquarium are the Spider Crabs, of which the large Thorn-back Crab, *Maia squinado*, is the common type. The shell of the Thorn-back is covered with knobs, spines and bristles which make a secure anchorage for seaweeds and all kinds of growths with which the creature methodically attires itself,—a form of " camouflage " carried to a high pitch of perfection. A large crab that has lived long and worked hard may indeed be completely hidden beneath his disguise. Of course, a change of shell necessitates the cloak of weeds being planted afresh, but the industrious animal never counts the labour. If no weeds are to hand he will solemnly cover himself with pebbles. These may roll off, but " dogged does it," and with a Job-like patience the crab persists in his self-appointed task, until he is indistinguishable from his surroundings. In dealing with crustaceans it is, of course, impossible to mention all the kinds which may be successfully kept in aquaria.

British waters alone provide over fifty species of crabs. Some crustaceans are so small as to escape the attention of all save the patient observer, but a few, apart from the crabs, lobsters and prawns, obtrude themselves before our notice in a variety of ways.

The Sand-hopper, *Gammarus marinus*, for instance, so common on every beach, is exhibited in large quantities in most aquaria, as it is used as food for the fish. The little creatures, often known as sand-fleas, are not as popular as they deserve to be, owing to their habit of co-mingling with seaside picnic parties and working their way between the sandwiches and into the teapot. We may be glad, however, that they abound, for not only do they constitute the principal fattening food of the young of many of our most valuable food fishes, but they do invaluable work as scavengers. Over twenty thousand have been counted " clearing up " a dead sea-urchin no bigger than a small orange. But for such " inspectors of nuisances " the sea would soon become polluted to a dangerous extent.

Less numerous than the sand-hopper are the various fish-lice, which are allied to the wood-lice of our gardens. They may often be seen adhering to the gill-covers of such fish as wrasse and cod. The species chiefly affecting the wrasse is a large form, *Anilocara mediterranea*,—about the size of a cockchafer. These creatures which are usually found in pairs, male and female, leave their unfortunate host at night when they swim about looking for fresh fields to conquer. *Bopy-*

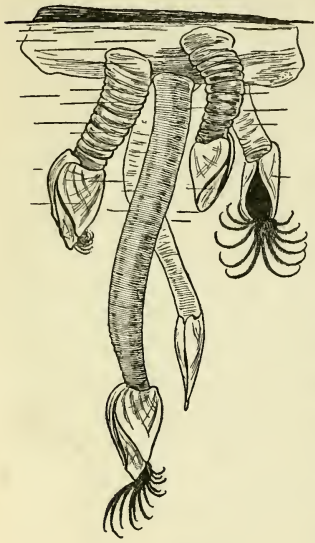
rus squillarum invades the gill-chambers of the prawn and causes an enormous enlargement of its host's carapace. A related form, *Limnoria lignorum*, has proved a serious scourge to man. In the old days, many of our large wooden ships have been rendered unseaworthy by this tiny pest, which, congregating in vast numbers, has riddled the timbers through and through until they appeared like so much sponge. To this day it causes much damage to harbour piles, dock gates, etc.

The majority of crustaceans are active creatures—here to-day and gone to-morrow. A few, however, having once sown their wild oats settle down for life, and anchor themselves permanently to any convenient shell, rock or piece of timber which may come to hand. Such are the Barnacles of which two great groups, the stalked barnacles and the acorn-barnacles, are common to our shores, and may sometimes be seen alive for short periods in public aquaria. The barnacles begin life as active, free-swimming, shrimp-like creatures, constantly changing their shells, and with each change become more and more adapted to a sedentary existence. When ready to settle down they anchor themselves by their antennæ—provided for the purpose with a kind of cement—whilst their legs which once rowed them vigorously through the sea become adapted merely to sweep the water for passing scraps of food.

The acorn-barnacles, which encrust every rock, are stony, conical-shaped buildings with an opening at

the top, guarded by a sort of folding door through which the feet are thrust at feeding time, and the scraping of millions of these minute doors may be quite distinctly heard at low tide as a sort of hissing sound.

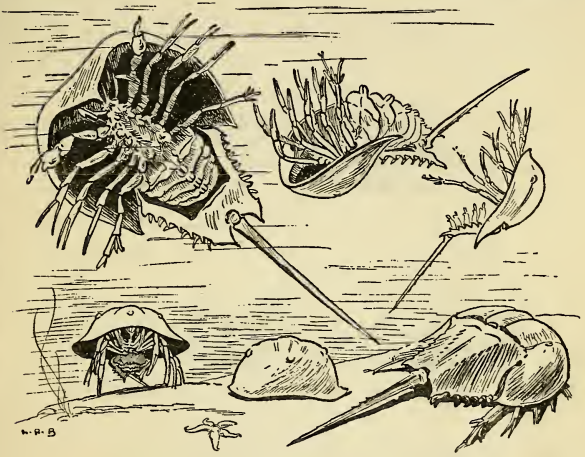
The goose-barnacles have long been famous from the old belief that they turned into geese. They anchor themselves by their antennæ much after the fashion of the acorn-barnacles, but the front portion of their heads grows to an enormous length with the shell-encased bodies at their opposite extremities. Unlike the acorn-barnacles that when adult for ever stand upon their heads on the same spot, the goose-barnacles attach themselves to floating timber from which they hang body downwards, raking in food from the water.



Goose-Barnacles.

A very strange degenerate relative of the barnacles is *Sacculina*, a soft oval-shaped creature which may often be observed attached to the undersurface of a shore crab. It begins life as a wanderer, as do all the

true barnacles. When, however, the time comes to settle down it sinks to the ocean-bed, discards every vestige of shell, and proceeds to affix itself to the first available crab, sucking nourishment from its host by means of long branched filaments. The crab is doomed, but before death supervenes the parasite

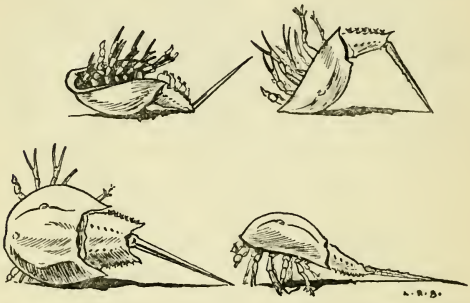


Horse-shoe or King Crab swimming and walking.

sometimes effects an extraordinary change in its host's anatomy, causing the reversal of its sex.

In the Horse-shoe Crab or King Crab, *Limulus polyphemus*, which is often exhibited in public aquaria, we have not a true crab, but a creature which is a representative of a group forming a connecting link between the crustaceans and their allies the scorpions, spiders,

and centipedes. The Horse-shoe Crab is a survival from the prehistoric past, and although now confined to the tropical and sub-tropical seas, once upon a time enjoyed a world-wide range. The reason for its survival is not difficult to explain. The animal is entirely useless to man, and its body contains so little nourishment that none save a few giant saw-fish think it worth their while to attack it. The Horse-shoe Crab subsists



HORSE-SHOE OR KING CRAB REGAINING ITS FEET AFTER HAVING BEEN TURNED OVER.

upon molluscs and small crustaceans found in the sand, in which it lives half-buried for the most part.

The upper portion of the body of these " crabs " is protected by two large bony shields, the first curved backwards at an angle and bearing four eyes, the second which is armed with spines pointing obliquely backwards. The body is armed behind by a long spike-like tail which is movably articulated and of service to the animal in helping it to recover its position when it

has fallen, or been turned on its back. The gills which are situated on the undersurface are composed of numbers of plates arranged like the leaves of a book and are supported by five pairs of limbs. The antennæ and jaws resemble limbs and terminate in small pincers. The true legs are short and entirely covered by the shields.

Off the coast of certain parts of America these creatures occur in hundreds of thousands, but even the most ingenious of speculators have failed to turn them to account.

The MOLLUSCA form one of the principal divisions of the Animal Kingdom, and includes such well-known creatures as the snail, slug, whelk, oyster, and octopus. The sixty thousand living species present an amazing array of contrasted forms, some being minute, whilst others rival the largest land animals in bulk. Representatives of the group abound in all parts of the world,—on land, in the fresh-waters, and especially in the oceans. They have a well-defined heart, and complex circulatory and nervous systems. In all cases where there is a distinct head, we find a tongue which may take the form of a rasp-like ribbon or a powerful beak. A characteristic feature of many molluscs is the shell, in which the great majority of species are more or less completely enclosed. The shell is composed of carbonate of lime, and is secreted by the animal. It may be formed of one piece or of

two or even more pieces. When the animal is the possessor of a shell made of a single piece it is known as a *univalve*; when of one made of two pieces joined together by a hinge it is called a *bivalve*. In the case of the former the shell is occasionally hidden by a covering of skin, but in the latter it is always uncovered. The foot, which may be broad and flat, thin and long or divided into a number of arms, is often very highly developed, and may be employed for such various purposes as crawling, burrowing, swimming, and even leaping.

The economic importance of the molluscs is considerable, many being edible, whilst their shells have been put to endless uses as ornaments, ingredients in cements and plasters, the basis of gravel paths, dyes, and, before the advent of coins, a medium of exchange.

The marine molluscs suitable for exhibition in the aquarium make a rather short catalogue, but include some interesting and beautiful examples, representative of each of the following four subdivisions into which the group is split up. These subdivisions are: (1) The *Gastropods*—snails, slugs, limpets, whelks, etc.; (2) The *Pelecypods*—the bivalves; (3) The *Scaphopods*—the toothshells, and (4) The *Cephalopods*—octopus, squids and cuttlefish.

The Gastropods, which are represented on our coasts by a large number of species, of which the whelk, limpet, winkle, and sea-hare make the most suitable aquarium exhibits, are all hatched with a

shell that may persist throughout life, degenerate into a mere scale, or disappear altogether. Some pass through a number of larval stages, whilst others begin life with an unmistakable family likeness.

The Limpet, *Patella vulgata*, is remarkable for its strongly developed homing instinct. Its strong shell forms a scar upon the rocks, which, with the aid of secretions produced from the animal, in time forms a shallow, but quite distinct pit. When covered with water as at high tide, the limpet sallies forth in search of food, returning to its little " dug-out " before the rock upon which it lives is exposed at low-water. Like many other vegetable-feeding molluscs, the creature is an efficient window-cleaner, and in the aquarium when promenading on the glass of its tank, the operations of its file-like tongue can be seen to advantage. This tongue is a ribbon which exceeds the shell in length and bears more than two thousand saw-edged teeth arranged in rows, the broken or worn-down teeth being replaced by new ones from the ranks behind. The tongue is coiled like a watch-spring, and when in use makes a scratching sound which is clearly audible through the glass front of the tank. The remarkable adhesive powers of the limpet are not only proverbial but true, scientifically conducted experiments having proved that the creature is able to resist a pull of over sixty pounds. The limpet is, however, by no means impregnable, for in the large Whelk, *Buccinum undatum*, it has a foe which with its

tongue will drill a neat little hole through its shell.

The whelk is able to close the mouth of its shell completely by means of the operculum,—a kind of horny lid,—a character which distinguishes it from a land-snail. It is further conspicuous for the great development of its siphon, a tube-shaped pipe through which the water is conducted to the gill-chamber, a contrivance characteristic of all marine snails. Its masses of egg-capsules are known to all, being amongst

WHELK (*Buccinum undatum*) AND EGGS.

the commonest objects washed up by the tide. Each of the little capsules contains about 500 eggs, but only three or four sally forth into the world as perfect whelks, as upon hatching the little creatures fall upon each other with murderous zest, devouring their weaker brethren and the unhatched eggs.

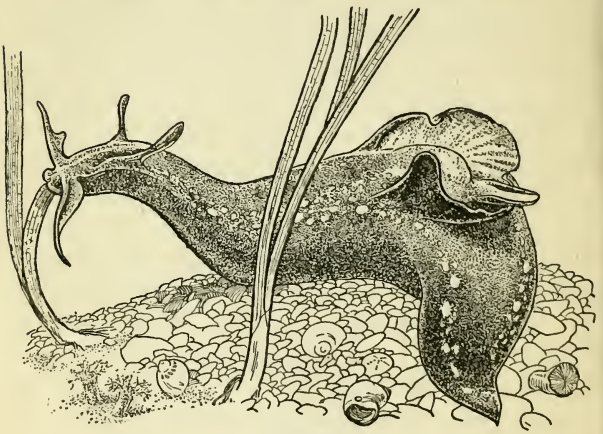
In the Common Periwinkle, *Littorina littorea*, the eggs are laid one or two at a time in transparent capsules, shaped like tiny dish-covers, which lie upon

the sand, or float in the water, hatching out about a week after they have been deposited. The baby winkles, although provided with shells, are at first free-swimming animals in the upper water layers where they stay for some weeks before settling down to browse upon the weed-covered rocks.

A very remarkable mollusc is the Slipper Limpet, *Crepidula fornicata*, which may be gathered in immense quantities off our coasts, especially in the Thames estuary. A native of America, fifty years ago it was unknown in this country. One evil day it came to England attached to some oysters, and now it is so firmly established that it is causing the greatest havoc in the oyster-beds where its presence is partly responsible for the big rise in the price of the bivalves during the past few years. When we consider that a single individual can lay more than twenty thousand eggs at a sitting its abundance is not to be wondered at.

The Sea-Hare, *Aplysia punctata*, which is quite common off the south-western coast, derives its popular name from a fancied resemblance to a crouching leveret,—not to its fleetness, for it is a decidedly sluggish creature. It is a slug-like animal, dark brown in colour, and having a thin internal shell covered by two great flaps of the mantle which can be considerably extended at will. The mantle, it should be explained, is present in all molluscs and is responsible for the building of the shell, which consists of several layers, the outermost being usually thick and

limy, and the innermost having an enamelled surface of " mother of pearl." The shell of the sea-hare is of little service to its owner, but in its power of ejecting great quantities of purple ink it has an efficient means of protection, for this ink or dye acts upon the principle of the war-time " smoke screen," and by the time the water has cleared the animal has



Sea-Hare.

made good its escape. The sea-hare is a purely vegetable feeder, and in its native state lives principally upon Sea-grass, *Zostra marina*, which it eats by biting off pieces about half an inch in length and swallowing them whole. In the aquarium it will thrive for short periods on ordinary lettuce.

Many of the true sea-slugs do well in aquaria.

Their gills are naked, and carried in rows upon the animals' backs where they display all manner of fantastic tree-like forms, some of them being gorgeous in the extreme.

The Sea Lemon, *Doris tuberculata*, closely resembles a large lemon cut in half, lengthwise, with a pair of short thick horns at one end, and a crown of gill-plumes at the other. It lays its eggs in the form of ribbons which are fastened to rocks, and arranged in a coil. They make interesting objects for study under the microscope, for it will then be seen that each egg contains three or four young that move about freely by means of rows of vibrating hairs, and that they are provided with tiny spiral shells—a remarkable side-light upon the probable ancestry of the sea-slugs. The adult " lemon " has a digestion which an ostrich might surely envy, for it feeds mainly upon the " crumb of bread " sponge, and its stomach upon dissection will be found to be crammed with the sponges' hard spines and needles.

The Plumed Sea-Slug, *Eolis papillosa*, is a species which will flourish in the aquarium upon a diet of small anemones, and one can but marvel at the strange nature of its food, for the anemones' countless stinging cells are fatal to most small animals, and highly repellent to quite large fish. Its gill-plumes are arranged in rows upon its back, and cover the entire length of the animal. They harmonize perfectly with the tentacles of the anemones upon which the slug browses.

The *Pelecypods* are probably economically the most important of all the molluscs, since a very large number of forms are regularly used as food, and several produce pearls. All have the shell made in two—usually equal—halves, joined by means of a cartilaginous hinge. They include some of the minutest, as well as the largest of all molluscs with external shells.

The visitor to the Zoo aquarium will not fail to notice in some of the large tropical marine tanks, oyster-like shells large enough to make the most admirable hip-baths. These belong to the Giant Clam, *Tridacna gigas*, an animal of gorgeous coloration, and large enough to make a square meal for at least fifty persons. It hails from the barrier reef, where it lies partially sheltered in the sand, and truly ghastly stories are recounted of divers walking on the reefs who have accidentally placed a foot between the half-opened shell, when instinctively the valves close in a vice-like grip. The remainder of the story can be left to the reader's imagination.

Similar tragedies on a minor scale occur every day on our coasts where large mussels close upon the toes of some inquisitive bird that, however, usually manages to escape by parting with the member thus detained. The shells of the giant clam and other molluscs inhabiting the barrier reef can be introduced into large tropical aquaria with good effect, being consistent with the exhibits and giving just that

touch of local colour requisite to make the tank a complete and convincing picture.

The Oyster, *Ostrea edulis*, the Cockle, *Cardium edule*, and the Scallop, *Pecten maximus*, are all of great importance in the national larder and are too well known to need introduction. Every year there is delivered at Billingsgate Market alone over one thousand tons of oysters, and a hundred tons of cockles and scallops. Many a romance might be written around the oyster alone. It bulked largely amongst the many lures which brought the Roman legions northwards, and it has formed the bedrock of fortunes, only exceeded by those amassed from the culture of its near relative the pearl oyster. Its life-history is very extraordinary, and has given rise to a vast library, and many parliamentary reports. We must condense our account into a single paragraph. The sexes are combined within the parent oyster, but do not mature simultaneously. An oyster can be female for a short period, and then male. It may contain about two million eggs which when the time is ripe are violently ejected from the parent, and are shot upwards in a cloud, to take their place in the vast congress of larval sea-animals which spend their infancy at or near the surface of the ocean. At this period in their existence from between the valves of the baby oysters there protrudes two flaps fringed with never-resting hairs and by means of these the little creatures swim nimbly about, until they fall, as do the

majority, beneath the claws or stinging cells of their many foes. Very few of the original two millions survive to adult oysterhood, but the gourmet may spare his regrets, for if every oyster were to attain maturity the whole of the world would in a very short time become covered with the piled-up shells of the bivalves. Such of the young oysters as survive a twenty-five days' sojourn at the sea-surface sink at the end of that time to the bottom where they fix themselves to any convenient object. When quite young the shells of the oysters are of equal size and both flat, but at this stage one becomes concave. The substance to which the mollusc attaches itself may determine its destiny for good or evil, and hence the floor of an oyster-bed is always carefully prepared. With all the care lavished on our oyster harvests, even the adult animals continue to suffer very severe depredations—from starfish, sea urchins, whelks, boring sponges, slipper limpets, and certain fish, and it would appear as if Nature is determined to maintain the balance without regard to man's effort to protect any particular animal.

The Edible Mussel, *Mytilus edulis*, enjoys a world-wide distribution, and whilst of great food value must be gathered with discretion since it can live under conditions of impurity which would prove fatal to most molluscs. This fact has its advantages for the aquarist, for the mussel is a most valuable " filter." Like most bivalves it is the possessor of two siphons,

through one of which it takes in water, extracting from it all manner of organic substances, whilst through the other it expels the purified water.

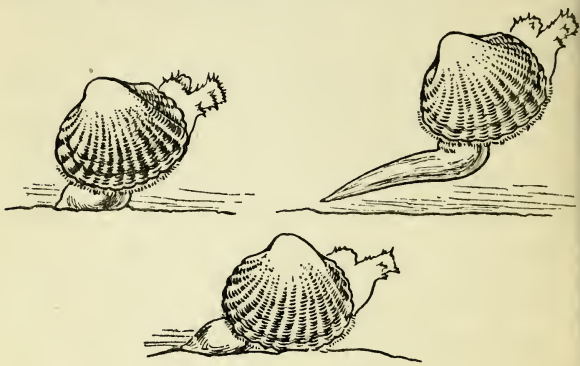
Unlike the oyster which anchors itself by cementing part of one of its shells with carbonate of lime to any convenient support, the mussel attaches itself by a number of threads which often form a large tuft of minute cables.

In one British bivalve, the large Fan Mussel, *Pinna fragilis*, these threads are so abundant and of so fine a texture that they can be woven into scarves and other garments. This mussel, which is horn-coloured and more or less transparent, is often the host of a curious little crab, *Pinnotheres*, which secretes itself within the shell of the mollusc. Should the crab die within its host, the mussel proceeds to bury its guest in a covering of the pearly nacre with which its shell is lined.

The Common Cockle is without doubt the most entertaining of all the bivalves, for it is the possessor of a large scarlet or orange foot with which it can burrow in the sand, hook itself to stones, or take the most astonishing leaps. This champion long-jumper simply presses its muscular foot against a stone, and by stiffening it suddenly projects itself for several feet. As a result of such a performance, people strolling along the gravel reaches of the seashore have frequently imagined themselves pelted with stones owing to hundreds of cockles leaping in unison to meet the incoming tide. To those not acquainted

with the habits of the cockle, the phenomenon, when it occurs at night upon a desolate beach, may be distinctly disconcerting.

The beautiful Scallop which has been so often immortalized and travestied in ornament can be kept with some success in aquaria. Whilst most



Common Cockle, leaping.

bivalves are only capable of distinguishing between light and dark, there are grounds for believing that scallops enjoy a much more efficient "eyesight," for any sudden alarm, such as the introduction of their deadliest foe, a big starfish, produces a most dramatic effect upon the part of the molluscs, which rise from the sandy floor and flap through the water at a considerable speed. This "flitting" is effected by the rapid opening and shutting of the valves of the shells. In early life they are much given to this means of

progression, but with advancing years they become more staid and sober, only making use of their leaping powers upon emergency. Like the oyster, the scallop requires about four years to attain maturity.

From time to time there may be seen suspended or floating in the tanks of public aquaria pieces of timber riddled with innumerable burrows, which the official label informs us are the work of the Ship-Worm, *Teredo navalis*. They are, however, not the work of a worm at all, but are merely annexes to the dwellings of certain bivalved molluscs. We know that a number of bivalves burrow, in the sand or mud ; the ship-worm, however, has a taste for timber. But to whatever depth it may dig to escape its foes it must still keep in touch with the outer world for breathing purposes, and to effect this the siphons are of enormous length.

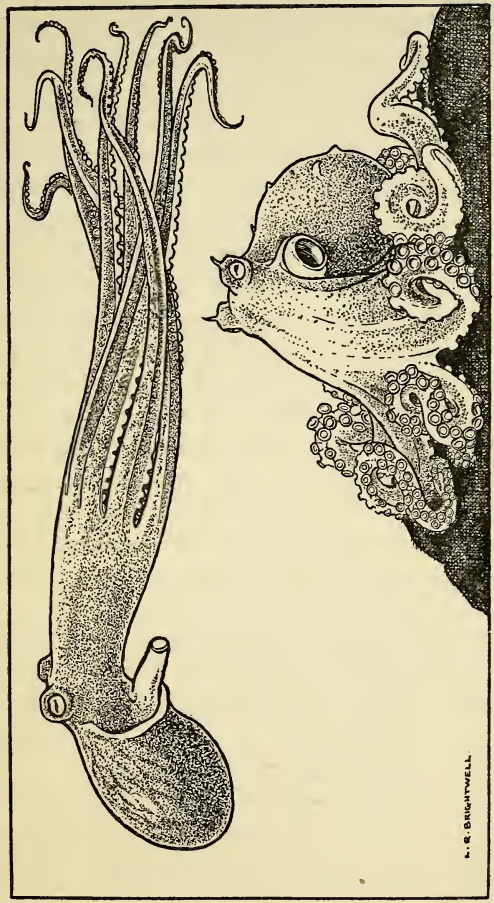
Beginning life as a free-swimming larva, this strange mollusc soon settles down and starts boring a tube into some convenient harbour pile or wooden ship. As it grows, tunnelling the while, the tube naturally becomes longer and longer and the siphons stretch. The two valves of the shell, which originally resembled those of a small cockle, degenerate into mere plates, but the tube continues to grow. Our native ship-worm can drive a shaft, nearly a foot in length, through the hardest timber, in under eight months, whilst certain foreign species may penetrate for a distance of over four feet. To-day, when steel-plated ships are the rule rather than the exception, the ship-worm

is not the menace that it was in days when it rotted the timbers of Drake's *Golden Hind*, or sufficiently destructive to merit the name " calamitas navium " originally bestowed upon it by Linnæus.

The " head-footed " molluscs or Cephalopods are represented to-day by the Octopus, Cuttlefish, Squid, Nautilus, and Argonaut. That in geological times they were far more numerous than they are now is proved by the fact that many of the rocks are built up of the remains of such shell-bearing forms as the ammonites. But although less numerous the living forms are so extraordinary, both in their habits and appearances, that they never fail to excite our wonder, and in the aquarium their exhibition may be counted upon to attract a large and speculative public. Unfortunately these animals require a greater amount of oxygen to keep them in health than any other marine animal, and as they make a habit of contaminating their travelling tanks by expelling a quantity of inky fluid, few ever arrive alive at inland aquaria.

The Octopus, *Polypus vulgaris*, which has ever been a prime favourite with the sensation-monger, and has fairly eclipsed the sea-serpent as a " silly season " topic, seldom exceeds a length of 8 feet in British waters, or more than 40 feet in tropical seas.

The long tapering arms of the animal represent the " foot " of the whelk or garden snail, which is in the case of the octopus divided into eight whip-like tentacles, each having its undersurface thickly studded



Octopus.

with about three hundred circular sucking discs. In the centre of the arms is the mouth, a horny structure shaped like a parrot's beak. The head is separated from the body by a slight constriction, and bears, in addition to the arms, two medium-sized eyes. The more or less globular-shaped body is small in proportion to the rest of the animal, and is enclosed in a fleshy covering which is analogous to the mantle of other molluscs. From it protrudes the siphon pipe which draws in water to vitalize the gills, and sustain the creature. On the water being exhausted of its oxygen it is expelled by the siphon with considerable force, and the current thus generated can be utilized to " blow " away the gravel or sand from the sea-bed until a convenient basin-shaped resting-place is obtained. The siphon further plays an important part in the locomotion of the octopus, for when in a hurry, or engaged in a long-distance swim, the creature relaxes its arms from their habitual hold upon the sea-floor, places them close together before the eyes, forming a dart-like formation, and breathes heavily and hurriedly. As a result the water is expelled with extra force and the animal can thus propel itself backwards through the water at a speed of several miles an hour. Sometimes the octopus, looking like a number of snakes hopelessly entangled with each other, is content to slowly writhe through the water ; on other occasions it will stride spider-wise over the rocks until it catches sight of a crab or other crustacean, when it will rise

Photograph by] OCTOPUS *[Neville Kingston.*

and then descend bodily upon its victim. It is an animal beautifully adapted to approach its quarry unobserved, and to avoid detection by its foes. No other creature ashore or afloat, not even the chameleon, is possessed of better powers of " camouflage," for the lax and pliant skin of the octopus, which is normally of a terra-cotta tint, can within a few seconds be made to match the colour of its surroundings.

Under no circumstances will the small octopus of our seas deliberately attack human beings, and any casualties that it has ever been responsible for have been due entirely to the shock aroused by its sinister appearance.

The octopus lives entirely on crustaceans and other molluscs, displaying the greatest artfulness when tackling its prey. A big crab or lobster is usually approached from behind, and the attacker after much manœuvring eventually secures the claws. The battle is then virtually over. Its patience when opening oysters is Job-like, and the creature is said, when this feat is almost accomplished, to place stones between the half-open valves to prevent them closing again. The staple diet of the octopus is, however, crabs, and to secure these he retreats into a rock-fissure which commands a good view of the surrounding country. On the approach of his victim the octopus extends one of his arms, and then gently flicks the crab with the tip, just between the eyes. The crabs appear to become hypnotized by this procedure and allow themselves to be drawn unprotesting into the operating

chamber, where if they are not eaten straight away they are kept until required. Of its many victims, only the lobster offers the slightest resistance. When actually feeding, the octopus neatly disarticulates its prey, and then proceeds to remove the flesh with the end of its tentacles, and an untidy pile of crab shells usually marks the entrance to its lair.

The octopus occasionally comes to the aquarium as a result of having investigated the interior of a lobster-pot and failed to find the exit.

Very similar to the above in general structure is the Lesser Octopus, *Eledone moschata*, which derives its specific name from a powerful odour of musk which it emits when handled. It is distinguished from the common octopus by having but a single row of suckers on each arm, instead of two.

Both *Polypus* and *Eledone* are migratory creatures visiting our northern shores only during very warm weather. They winter in the south. In the autumn they may occasionally be caught off the Channel Islands and the French coasts in fairly large numbers, their flesh being used for food and bait.

The Cuttlefish and Squids differ from the octopus in the possession of ten arms and having the boat-shaped bodies supported by an internal shell of a calcareous or horny nature. They have two extra long arms which bear suckers only at their club-shaped tips, the entire apparatus being neatly coiled up when not in action, and stowed away in two pockets, one on either

side of the creature's head. Should a fish approach, the arms are " run out " with lightning-like rapidity and the prey is secured by the suckered tips. Cuttle-fish and squids rely wholly upon fish for their support, and unlike the octopus, which is rather sparing of its ink and usually a mere " passive resister " when attacked, will eject their ink on the slightest provocation. When handled they are quick to use their sharp beak-like mandibles. The skin of these animals is richly supplied with colouring matter which is under the direct control of the animal, but unlike that of the octopus is more or less rigid and cannot be drawn into folds. The long body is surrounded with fins which by a winnowing motion help to propel the animal forward. Sometimes the fins are so highly developed that by means of them the animal can take flying leaps out of the water, on which occasions it sometimes lands on the decks of vessels. There are plenty of " big squid " stories—some apparently not without foundation—as specimens with bodies measuring nearly 20 feet in length, with arms to match, have on more than one occasion been cast ashore off the coasts of Newfoundland and the west of Ireland. Such monsters have eyes 15 inches across, suckers as big as saucers, and jaws that dwarf the beaks of the largest known vultures. Most Cephalopods are hatched from eggs which are laid attached to a common stem like a bunch of grapes, and are securely anchored to a rock. The young on hatching out resemble their parents.

The Common Cuttlefish, *Sepia officinalis*, is abundant off our sandy shores, and is often taken in the shrimp trawl, and seine net. It makes an ideal bait for most fish, and its firm opalescent flesh is not at all unpalatable when properly cooked. The well-known " cuttle bone " lies in the living animal just beneath the skin of the back, and is made of innumerable overlapping limy plates.

The Squid, *Loligo forbesi*, is a frequent summer visitor and is a near relative of the giant forms which occur in deep water. It has a flexible horny " pen " in place of the cuttle's limy " bone," and provides us with the " sepia ink." Squids live in vast shoals which manœuvre with military precision, and in Italy where the majority are captured for commercial purposes they are netted or speared. Sometimes branches are suspended in the water and the animals on approaching to lay their eggs on them are surrounded and caught. Another ingenious method of capture employed by the Italians is by means of towing a female squid behind a boat, when the males gather round in their hundreds.

The TUNICATES, some of which are popularly known as sea-squirts, are present everywhere in the sea, and frequently appear in the aquarium where they will be dismissed by the casual observer as being either vegetable growths, or at the best unattractive relatives of the more beautiful anemones. In reality they are

of the utmost interest, for they are more closely akin to ourselves than the largest of octopuses or most lively of lobsters. They are creatures that have halted on the road of evolution,—degenerates who have stopped half-way, standing for ever between those animals that have been endowed with a well-developed spinal column, and the great army of invertebrates.

The name " tunicate " refers to the leathery or gelatinous tunic in which the animals are enclosed, whilst the popular term " sea-squirt " refers to their habit of violently ejecting a thin stream of water when molested as they cling to the rocks at low tide.

Every animal in its youth gives us a hint of its early ancestry, and our chief interest in these creatures lies in their infancy. Whilst still within the egg, or parent, a typical tunicate passes through several stages. It begins as a single cell, and slowly developing presents succeeding phases which recall certain higher forms of life. It is usually hatched from one of many eggs and makes its first public appearance as a free-swimming, tadpole-shaped creature, having a brain, an eye, the means of hearing, and a well-defined nerve chord, foreshadowing a spinal column, from which such ponderous vertebræ as those of the whale may originally have sprung. This minute creature leads a care-free existence for a few days, and then its early promise ends. Settling at the bottom of the sea, where it anchors itself for life, it loses its tail, eye and " ear," acquires a tough leathery tunic and becomes

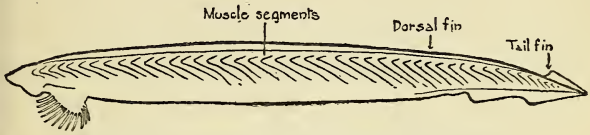
a mere sack incapable of further travels. A tunicate, *Oikopleura dioica*, which is common in home waters, differs from the majority in remaining in the "tadpole" stage throughout life. It is known as the "house-builder" from its habit of constructing gelatinous barrel-shaped houses in which it floats about. By far the greater number of tunicates live as "fixtures" secure within their jackets which are fitted with two openings, the one aperture acting as an inhalent, the other as an exhalent. The interior of the animal is lined with minute vibratory hairs which sweep particles of food—microscopic plants and animals—into the stomach and also ensure an ever fresh supply of water passing over the innumerable gill-slits. The heart is unique in being a reversible engine, pumping the blood first one way, and then, after a short interval, in the opposite direction. The blood-flow is consequently continually changing direction.

The large Tube Sea-Squirt, *Ciona intestinalis*, abundant on all our coasts, is a rather handsome creature of graceful flask-like form, apple-green in colour, with the rim of each opening tinted orange. It grows to a height of over a foot.

Very striking are the tunicates which live in colonies, and are known by the name of Golden Stars, *Botryllus violaceus*. They form great star-spangled masses presenting an endless range of brilliant and contrasting tints, the gelatinous sheets of stars covering weeds, rocks, shells, and sometimes even the backs of crabs.

Each star represents an individual, yet all are connected one with the other, and share a common blood-circulatory system. They reproduce both by budding as in the case of the anemones, and by means of eggs.

A closely allied form which makes a very striking exhibit in the aquarium is the red-coloured *Leptocinum lacazii*, and its appearance on the rocks may be gathered from Victor Hugo's reference to it in the *Toilers of the Sea*, where in describing a sea-cave he states "the



LANCELET OR AMPHIOXUS (*Branchiostoma lanceolatus*).

walls were splashed with crimson stains as if giants had been fighting there."

The tadpole-shaped Lancelet or Amphioxus, *Branchiostoma lanceolatus*, a creature at one time regarded as a fish, is allied to the sea-squirts, but still higher in the scale of life, being provided with an elastic rod—the notochord—which runs along the entire length of its head and body. It feeds and breathes exactly as do its less important relatives, namely by means of vibratory hairs which sweep the water into its interior.

The lancelet can swim with ease in either direction, but during the daytime prefers to remain buried in the sand, where it is securely hidden unless dug up by a wandering crab, or the all-investigating naturalist.

CHAPTER II

FISHES

IN reviewing the fishes generally shown in large marine aquaria we shall begin with the sharks,—not because they are the largest fish afloat, but by reason of their structure which establishes the fact that they are far behind the majority of living fish in development, and ruled the seas long before most of the modern forms were evolved. " Shark," it should be explained, is a loose term applicable not only to those gigantic man-eaters which are so justly dreaded, but likewise to the many kinds of comparatively small harmless dog-fish. A dog-fish is a small shark, and a shark is a big dog-fish.

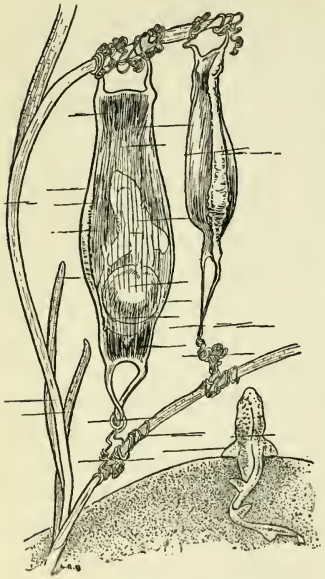
All these fish have scaleless skins, the lack of scales being compensated for by the presence of millions of tiny knobs, or needles, which form a hard, rasp-like surface calculated to turn the teeth of most fish, and sometimes even the point of a knife or harpoon. The skin can be converted into a leather (shagreen), and is used for polishing wood, ivory, and metal. Indeed, man gets his own back on the shark for all the loss it incurs to human life and property, for not only is the fish's skin put to many uses, but its teeth are converted

into ornaments, its spinal column into walking-sticks, its fins into soup, its liver into oil, its flesh into a variety of dishes, and any part left over may reach the public in the form of a patent medicine or fertilizer.

In the members of the shark family the mouth is situated on the undersurface of the head, whilst the neck is provided with five or more gill-slits on each side, but no gill-cover as in normal fishes. The lobes of the tail are unequal, the upper, through which the backbone passes, being the larger. In the aquarium quite small sharks and dog-fish appear to great advantage and do well. Large specimens cannot be exhibited, as apart from making serious inroads on the weekly food-bill, they take up too much " elbow room."

Unlike the majority of true fishes which lay their eggs by the thousand or even million, sharks and dog-fish seldom bring forth more than twenty or thirty young. Sometimes these are born alive, but more frequently they are launched upon the world in amber-coloured flask-shaped horny cases, which are anchored to seaweeds by means of long tendrils. The baby dog-fish can be clearly seen in all stages of development through the transparent walls of the egg-case, and when hatched is indistinguishable from its parents in general appearance, save for the presence of a feeding bottle which it carries in the form of a yolk-sack, attached to its undersurface. As soon as the yolk-sack is absorbed, the fish embarks upon a life of destruction which has earned it a bad name amongst fishermen.

Less than twenty years ago the dog-fish was regarded as a mere nuisance, but as a result of investigations by the Ministry of Fisheries the excellence of its flesh has been firmly established, and to-day enormous quantities are brought to the market.



Egg-cases of the Dog-fish.

The forms usually seen in aquaria are mostly southern ones, such as the Spur-Dog, *Squalus acanthias*, the Nursehound, *Scyliarhinus stellasis*, and the Spotted Dog, *Scyliarhinus canicula*.

If the reader can imagine a dog-fish being put through a clothes-ringer and surviving the ordeal, he will have a very fair conception of the appearance of the Skates or Rays. They are shark-like fishes which have spent so much time on the sea-bed lying half-buried in the sand, that they have become extraordinarily flattened. The details in which they differ from the sharks and dog-fishes are comparatively

slight, and fundamentally the two forms, although so dissimilar in outline, are built upon the same plan.

The Monk-Fish, *Squatina angelus*, so called from the resemblance of its rounded head and broad pectoral fins to a monk's hooded cowl, is too flat and " splayed " to be a dog-fish, and too narrow to be a true skate. It swims like a shark by means of its tail and not by undulations of its large breast fins as do the skate. It feeds however in the manner of a skate, lying half-buried in the sand and arresting passers-by that are not too large to be swallowed whole. Angel-fish, Fiddle-fish, Monk, Puppy, Buffoon are only a few of the printable names by which the fish, which may attain a length of over 5 feet, is known to the trawlermen who bring it to market where its carcass, after being dismembered, is sold under some name that sounds attractive to the public. The true skates or rays are all edible and of great food-value, being next to the herring unrivalled in the amount of nutriment contained per fish. Some grow to a huge size, and all are beautifully decorated with patterns of infinite variety.

The peculiarly broad form of the body, which is compressed from above and below, is due to the extraordinary development of the breast fins, which extend nearly to the tip of the snout, passing over the gill-slits which are situated on the lower surface. As in the case of most dog-fish, skates produce their eggs each enclosed in a horny envelope. These, however, are rectangular in form and have a horn or handle at each

corner which serves to anchor the egg-case to weedy rock-fissures. Slits in the horns admit the free entrance and exit of the sea-water, which as the embryo develops is further aerated by the rhythmic movements of the little creature's tail. The egg-cases vary much in size according to the species, some seldom exceeding 3 or 4 inches in length, whilst others such as those of the Bottle-nosed Skate, *Raia marginata*, may attain a length of 18 inches. The rate of incubation depends to a large extent upon the temperature of the surrounding water and may vary from four to ten months. Just how many eggs are laid per skate is still a matter of conjecture, but one in the Plymouth aquarium was observed to lay thirty in the course of six weeks. In common with those of the dog-fish, the empty egg-cases which are so frequently washed up on the shore are variously known as mermaids' purses, pixie purses, and sailors' purses. Skates are fascinating creatures in the aquarium in which they glide over the sand, and flap their huge pectoral fins when swimming in a manner suggestive of giant bats. Further, the resemblance of their undersurface to a grotesque human face makes an irresistible appeal to the frivolous spectator.

About a dozen species of skate are commonly used for food in this country, all of which frequently make an appearance in the aquarium where they may live for several years. The largest is the Bottle-nosed Skate which may reach a length of 9 feet and an equal width, and weigh nearly 5 cwt. Such monsters

THE DOGFISH AND SKATE TANK.

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naturally require an enormous amount of food to sustain them, and one recently examined was found to contain three mackerel, two skate over a foot in width, a four-pound lobster, a coal-fish, a quart of assorted crabs and a number of small plaice. Some of the skates, such as the Whip Ray of tropical seas, have large barbed spines on their tails, capable of inflicting poisonous and often mortal wounds. Our own Thornback Ray, *Raia clavata*, is armoured all over with sharp thorns that make it a dangerous fish to handle, whilst the sickle-shaped blades in the claspers of the male can do terrible damage to the hand that incautiously seizes them.

The Torpedo Ray, *Torpedo marmorata*, is occasionally met with off our southern coasts. It is unique in that it is our only native " electric " fish, being provided with a veritable galvanic battery capable of giving very severe shocks. The electric organs which are kidney shaped and are supplied with numbers of branched nerves are situated on either side of the head, and occupy the whole thickness between the upper and the lower surface. They give rise to a very strong electric current which will make an electric lamp glow, render the needle magnetic, and emit a spark. In mediæval times the fish was used as a cure for rheumatism, the patient being made to stand barefooted on the living fish.

We shall now consider the typical bony fishes beginning with the members of the Herring-family, which

are unfortunately seldom represented for long in the aquarium. Nothing short of the open sea is apparently large enough for these free-rangeing fish, for kept in a tank they will swim round and round, each fish nibbling at the tail of the fish immediately in front. At Brighton it was found that the herring-shoals introduced into the aquarium became so panic-stricken that they dashed themselves against the glass. To obviate this a large rock was erected in the middle of the tank, with the result that the fish resigned themselves to swimming round it, continuously day and night, doubtless under the impression that they were steadily moving forward.

The Herring, *Clupea harengus*, in captivity is apt at night to collide with the rockwork of its tank, which should therefore be faintly illuminated. It is a very prolific fish, which is fortunate when we consider that nearly three hundred thousand millions are landed annually in Great Britain alone. Less than one-quarter of these fish are for home consumption, the remainder being exported to foreign countries. From the fishery point of view, next in importance to the herring is the Pilchard, *Clupea pilchardus*, which in its young state is known as a sardine. Like the Sprat, *Clupea sprattus*, another member of the herring-family, it has no place in the aquarium for long, where its chief value lies in its use as a source of nourishment for hardier exhibits.

The Conger, *Conger vulgaris*, is the largest member of the eel-family, females sometimes measuring over

8 feet in length, such specimens weighing about 130 lbs. Whilst common inshore, frequently invading lobster-pots, when the spawning season arrives it goes far out into the deepest parts of the Atlantic, there to deposit some eight million eggs. Lurid stories have been told of giant congers attacking divers, whilst the fish has frequently been known to fairly monopolize a small boat when hauled on board by anglers more courageous than skilful. In the aquarium it makes an attractive exhibit, becoming so tame that at feeding time even large specimens will not only take food from the hand, but suffer themselves to be lifted bodily out of the water.

The Pipefishes and Sea-horses are perhaps the most popular of all the marine aquarium fishes, their grotesque forms and quaintly dignified movements at once stamping them as unique. Their family affairs are further unparalleled in the fish realms of " child welfare." In the breeding season the female of most pipefishes and all sea-horses places the eggs, one at a time, in an abdominal pouch with which the male is provided, the pouch consisting of overlapping folds of skin. The eggs are carried by the male until hatched, when the infant fish follow their parent for some time, often resting themselves by taking a turn with their long prehensile tails round any convenient part of their father.

Four species of pipefish, the Great Pipefish, *Syngnathus acus*, the Broad-nosed Pipefish, *Siphonostoma*

typhle, the Ocean Pipefish, *Nerophis aequoreus*, and the small Worm Pipefish, *Nerophis lumbriciformis*, are common off our shores, where they abound in banks of sea-grass. They are very attenuated in form and harmonize perfectly with the trailing ponds of the weeds amongst which they live. The male of the Ocean Pipefish has no abdominal pouch, the eggs being carried, glued by a sticky secretion which it exudes, to the undersurface of its body.

In the pipefishes the tail is only slightly prehensile, but in the Sea-horse, *Hippocampus antiquorum*, it forms as efficient a grasping organ as that of a spider monkey. Sea-horses, which recall the knights of the chess-board, swim in an upright position by means of their fan-shaped fins working on the principle of the screw-propeller, the movement being quite rhythmical owing to each of the fin-rays striking the water in succession. The Sea-horse, which is very common in the Mediterranean and the Bay of Biscay, is a rare visitor to our shores. Those in the Zoo aquarium are obtained from Arcachon. They are conveyed to Paris by train and from there, in order to shorten their journey, are transported by aeroplane to London. The provision of suitable food for these quaint creatures at first presented something of a problem, for the minute marine crustacea which when at home the "horses" suck into their tiny tubular mouths could not be obtained in sufficient quantities. Eventually the common fresh-water "flea," *Daphnia*, was found to form an excellent

THE PIPEFISH AND SEA HORSE TANK.

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substitute. It will not live more than five minutes in salt-water, but the sea-horses seldom give it a chance of dying by drowning.

In striking contrast is the Grey Mullet, *Mugil capito*, which in conformity with its torpedo-shaped body is remarkable for the rapidity of its movements. It is a sociable fish often entering estuaries in large shoals, in search of the weedy growths which harbour the small crustaceans upon which it feeds. Its thick soft lips are well adapted for browsing, and its rather bird-like stomach for grinding crustaceous shells. The agility of the fish is proverbial, and it will often evade the net by leaping high above it. A shoal which a few years ago penetrated some miles up the river Arun on being cornered in a small backwater made such desperate attempts to escape that most of the fish flung themselves high and dry upon the bank. In the aquarium the Grey Mullet does exceedingly well, specimens having been recorded to have lived for over ten years in captivity.

The Cod, *Gadus marrhua*, with the exception of the Ling, *Molva vulgaris*,—a fish which does not thrive in the aquarium—is the largest representative of a very important group. Not only are all the members of the cod-family edible, but their livers yield valuable oils, and their swim-bladders many grades of isinglass.

In the aquarium the cod forms a striking contrast to the colourless mass of flesh upon the fish-stall which bears its name. The upper surface of its body gleams

with vivid green and golden brown, shot with little blotches of pearly white, whilst its silvery undersurface shines with delicate prismatic tints. It is a powerful swimmer, and its gem-like eyes are assisted in the search for food by the long barbule depending from the lower jaw, which acts as a probe. Twisting and shooting in all directions it searches the sand until it finds a shrimp, crab, or flat-fish. Few things come amiss to the cod. Various kinds of fish, crabs, lobsters, cockles, octopods, tin cans, and portions of seamen's boots,—all these and still more have been found in the cod's interior. Like the herring it is a migratory fish, and very prolific, laying up to eight million eggs at a "sitting." In the aquarium the cod will thrive, provided the water is kept cool, during the summer months. The Whiting, *Gadus merlangus*, is a shallow-water form that does well in aquaria.

The small Bearded Rocklings—genus *Motella*—of which there are several species, commend themselves to the amateur aquarist, as few creatures, provided they are given plenty of shelter in the form of weeds, stones, and rocky caverns in which to hide away, are more suitable for the small marine aquarium. The fish, which take their name from the barbules which hang from their jaws when quite young, live at the surface, when they are known to the fishermen as "mackerel midges."

The John Dory, *Zeus faber*, is a fish which even the most casual visitor seldom overlooks, for its strange

Photograph by] [*Neville Kingston.*

JOHN DORY.

Photograph by] [*Neville Kingston.*

JOHN DORY.
In the act of capturing its prey.

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form, brilliant colouring, and ludicrously mournful expression make it unforgettable. A ribald observer once suggested that its expression might be the result of the fish having caught sight of its own reflection. Actually it is largely due to the form of its telescopic mouth, which can be extended and withdrawn with lightning rapidity. The John Dory is a strategist and approaches his prey with caution. His body being so compressed laterally as to be reduced to a mere line when seen from the front, he is rarely spotted by his intended victim until too late. As the prospects of a meal become more imminent, bars and streaks of deep chestnut-brown and vivid blue suddenly break out upon his normally gold-coloured sides. Presently his great dorsal fin rises, crowning him with an enormous crest. At the same time the mouth is shot forth and the desired fish or prawn vanishes for ever.

The name John Dory is in all probability a corruption of *jaune dorée*, in allusion to the fish's golden colour, whilst the name of Peter's Fish, which it shares with the Haddock, is attributable to the large circular black spot just behind the pectoral fin,—St. Peter's finger-marks, according to legend.

The eyes of the John Dory, as in certain other fish, are highly mobile and move independently, thus helping in giving a range of quaint facial expressions to which it owes much of its popularity in the aquarium.

A visit to the aquarium will help us to see the Flat-fishes, which include the Halibut, Turbot, Brill,

Flounder, Sole, Lemon Sole, Dab, and Plaice in their true light. Let us trace the life-history of one of them —say the Plaice. The fish is hatched from one of a clutch of half a million eggs. The little creature emerges looking like any normal fish, measuring one-seventieth of an inch in length. The eyes, which are the only noticeable thing about it—for the rest of its anatomy is as transparent and colourless as glass—are very large, and situated one on either side of the head. For some weeks the infant plaice lives at or near the surface of the water feasting on the microscopic plants and animals which there abound. In the course of a few weeks, however, an extraordinary change takes place. The body then shows a tendency to tilt to one side, and the swimming powers of the fish desert it. To meet this distressful state of affairs its " under eye," i.e. the one turned towards the sea-floor, steadily creeps round the head until it all but meets its fellow. The fish, when it is three months old, has sunk to the bottom to rest upon the sandy sea-bed for good, and by that time it stands a flat-fish confessed, with both its eyes situated close together on the same side of the body. This one-sided view of life has brought about many other modifications, apart from the adjustment of the eyes. The side of the body which lies on the sand through being denied the light has become white, whilst the upper surface, being sensitive to light and richly endowed with pigment cells, has become coloured. Now and again, however, we may come

THE JOHN DORY TANK.

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across a flat-fish with either colouring on both sides, or with part of the upper half white. Some forms swim and lie on the ground with their right side uppermost ; others with the left side. The plaice, like most other flat-fish, can at once adapt itself to its surroundings, and become one with its background, at a moment's notice. Experiments have shown that these fish can " take on " almost any surrounding pattern —that of a chess-board, for instance—with such fidelity as to render themselves quite indistinguishable. In the aquarium, flat-fish not only assume the colour of the sand of the bed of their tank, but partially cover themselves with the same, until only the two eyes, which work independently, protrude from the surface like twin periscopes sweeping the surroundings in search of possible victims.

The Plaice, *Pleuronectes platessa*, which may attain a length of 20 inches, and a weight of 15 lb., is not nearly so common a fish as it was. Its decrease in numbers is due to the steam trawler, which has done much to raise its market value by destroying the ova and young, thus defeating its own ends. To the plaice we owe much of our present knowledge of fish migration. The subject is a romantic one. The survey-ship from a Marine Biological Station trawls for the fish, which when caught are kept in well-aerated tanks on board. Each specimen is dealt with one by one, and embellished with a passport in the form of a disc bearing a number, and giving details of the locality where the

fish has been released. Years later one of the specimens may be caught by a trawler and forwarded to the proper quarters, where its history is elucidated by experts. It is well established that plaice will travel hundreds of miles in search of food and suitable breeding grounds, and that those living in certain localities increase in weight at a far more rapid pace than those emanating from others. Such knowledge has led to a regular system of transplanting the fish, which are " bedded out " on the most favourable grounds.

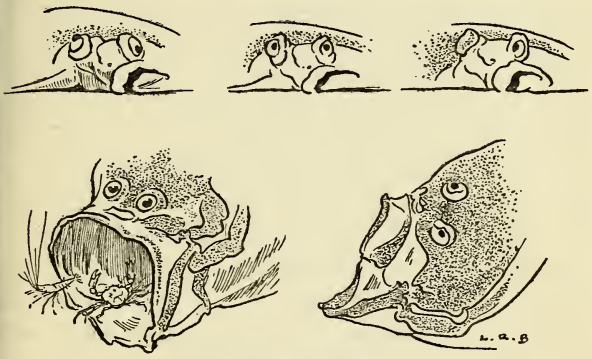
The Turbot, *Rhombus maximus*, one of the largest of the flat-fish, attaining a length of 3 feet, is extremely prolific, the number of eggs that a large female will carry having been calculated at over ten million. The skin of the upper surface of its rounded body is studded with hard, bony knobs. Its coloration is admirably in keeping with its surroundings and the many specimens in the large marine tank in the London Zoo are in consequence often invisible to the public. Turbot become very tame in captivity, and will feed from the hand.

Amongst the hardiest of all flat-fish is the much-prized Sole, *Solea vulgaris*, and the Lemon Sole, *Pleuronectes microcephalus*, which although not a true sole, but a species of dab, is often palmed off by the fishmonger upon his unwary or ignorant customer as the real thing.

The Halibut, *Hippoglossus vulgaris*, the largest flat-fish known, specimens large enough to cover a full-

sized billiard table being of frequent occurrence, does not, as a rule, live very long in captivity, and does not adapt itself nearly so well to aquarium life as does the turbot. Like many other delectable animals, the halibut is a foul feeder and is most plentiful in the trawl net after plenty of offal has been thrown overboard from a previous haul.

A hardy member of the Sea-Perch family is the



Heads of Flat-fish.

beautiful silvery Bass, *Morone labrax*, which may attain a weight of over 30 lb. It is very abundant along the southern coast of England, swimming in shoals quite near the shore. Specimens kept in the Zoo aquarium grow very rapidly on a diet of *Gammarus*, prawns, and flat-fish. Some introduced into the tanks weighing no more than a pound within a year turned the scale at more than treble that weight.

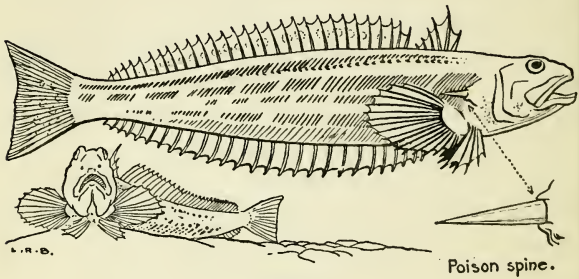
The Wrasses are inshore fishes of ordinary shape and of no food-value. They, however, command our admiration in the aquarium by reason of their brilliant coloration. The peacock's tail, the butterfly's wing, —these and many other wonderful colour schemes are equalled, if not excelled, by the scales of this common fish, for they light up the jade-green of the aquarium tanks with a glow of colour that conjures up visions of coral reefs set in an azure sea.

Scientifically the wrasses are known as " thick-lipped fishes " owing to the fact that they possess a pair of thick " cushiony " lips which conceal a set of teeth that belie the fish's placid expression. These teeth vary in shape, those of the jaws being fang-like, whilst on the palate and back of the throat they are flattened and well adapted for crushing the shells of the molluscs and crustaceans upon which these gaily coloured fish habitually feed. No shell is too hard for a wrasse to tackle, provided there is something edible inside, and it will nibble limpets from a rock or smash to pulp a crab nearly as large as its head with equal gusto and enjoyment. Its table manners leave much to be desired, as when feeding it crunches its teeth and at the same time smacks its lips so loudly that it can easily be heard by the spectator behind the glass of the aquarium. Wrasse lead an exemplary married life, both parents taking an equal share in the making of the home, which they fashion out of scraps of seaweed, the size of the nest depending upon the species respon-

ible for its architecture. The largest of our wrasses —the Ballan Wrasse, *Labrus bergylta*—makes a bird-ike nest considerably larger than a crow's, and dis-perses its eggs haphazard throughout the entire mass. The offspring at first swim near the surface of the water, living upon minute organisms, but as they " come of age " take to the rocky parts of the sea-floor and there crack shells for a living. Some tropical species enjoy such a remarkable set of " grinders " that they actually browse upon the corals as easily as a horse does upon grass. Few kinds of fish do better than wrasse in the aquarium, provided the water is well aerated and suitable food in the form of prawns, sand-hoppers, and crabs is supplied.

The Weevers, a small group of bottom-haunting, sand-loving fish, are provided with poison organs situated at the base of hollow spines, and with these are capable of inflicting very serious wounds. The spines—situated one on the first dorsal fin and one on either side of the gill-cover—are analogous to the poison-fangs of a serpent, being connected with glands which secrete a poisonous fluid. The name " weever," which is derived from the old English word " wivre " signifying viper, clearly establishes the fact that the fish has been in ill repute for centuries. A weever-sting on the hand may result in the arm swelling to the size of a bolster, and small wonder that the notice " Ware Weevers " is displayed on many of our piers during the height of the holiday fishing season. Two

species are common in home waters,—the Greater Weever, *Trachinus draco*, which grows to the size of an average herring, and the Lesser Weever, *Trachinus vipera*, which seldom exceeds 6 inches in length. *T. vipera* in some localities is exceedingly abundant in shallow water, where it sometimes introduces itself to the incautious paddler. Of the two species the larger is much the hardier in the aquarium.



WEEVER.

The Mackerel, *Scomber scombrus*, presents fish-form in its most perfect aspect, for the creature is built for attaining the maximum of speed with the minimum of effort. It has consequently been taken as a model by the ship designer, and by those responsible for the perfection of the submarine and its offspring the torpedo. The mackerel is designed to cleave the water as an arrow cleaves the air. Further, it is all but invisible in its natural element, the wavy pattern of its back blending with the ruffled sea-surface, whilst seen from

below its pearly white undersurface harmonizes with the light from above. It is a very shy fish and like the herring easily becomes panic-stricken, especially when confined in small aquaria or travelling tanks. It is occasionally possible to introduce mackerel into large aquaria situated by the sea such as those at Brighton and Plymouth, where they may thrive for a considerable period. There is, however, little hope of their delighting visitors at the Zoo, or other inland aquarium.

The Gobies are all small inshore fishes, often appearing in such abundance as to fairly choke the shrimp-trawl or seine net. They may at once be distinguished by their two pelvic or breast fins being fused together, so forming a hollow saucer-shaped sucker by means of which the fish are able to adhere to rocks. Apart from this peculiar feature they are very ordinary-looking sand-dwellers, with smooth, almost scaleless skins that harmonize well with their surroundings. Their eyes, like those of most bottom-fish, are placed rather close together, near the top of the head. In accordance with our national extravagance we must follow precedent and state that gobies are valueless as food. The more thrifty nations bordering the Mediterranean, however, deem them otherwise, and regularly bring vast numbers to market where they find a ready sale amongst all classes.

The home life of the gobies cannot fail to interest. Each species appears to have its own particular idea of

an "ideal home," and both sexes participate in its construction. As with most fish, however, the bulk of the family cares fall upon the male. A pair of newly-wed gobies make it their first duty to find a safe site wherein to deposit the precious eggs, and start house hunting. Sometimes a shell is selected, sometimes an empty sea-urchin, or even a bottle. The site selected, the eggs are deposited and carefully guarded by the expectant father. At first the spindle-shaped eggs are all but colourless. Later, as the eyes of the young fish develop, they assume a greenish colour. On hatching they are slightly hampered by their yolk-sac, which, however, is absorbed in under a week, by which time the infant fish can fend for themselves.

The Sand Goby, *Gobius minutus*, shows more independence than his relatives, and is not content to find a house, but selects his own site and builds one himself. This is accomplished by banking up the sand with the snout until it forms a rampart round an empty shell. The sand beneath the shell is then dug out until a deep and well-protected basin is formed. Within this the female lays her eggs, which are duly aerated by a constant fanning on the part of the male's fins. Although not endowed with any special armour, the father displays reckless courage in the defence of his young.

With the exception of the Giant Goby, *Gobius capito*, which is found at rare intervals off the coast of Cornwall and may attain a length of 10 inches,

Photograph by] *[Central News.*

WOLF FISH

the eight British species of goby are all quite diminutive fishes rarely exceeding half a foot in length.

The Black Goby, *Gobius niger*, should commend itself to the aquarist since it can be gradually acclimatized to fresh-water. This power of adaptability is developed in a tropical goby known as the Mud Skipper, *Periopthalmus koelreuteri*, which has the pectoral fins developed into regular limbs and not only spends long periods perambulating the dry land, but even climbs trees and bushes, where it varies its normal diet of shrimps and baby crabs with a tasty snack of butterfly or mosquito.

The Blennies are essentially rock-haunting fishes, very abundant in both hemispheres, and occurring at all depths. Some are confined to the abyssal depths, whilst others are purely coastal and spend all their time in quite shallow water. Four species are found in our rock pools and may be kept successfully in the aquarium.

The Wolf Fish, *Anarrhicas lupus*, is the giant of the group, attaining an extreme length of 6 feet. It is a northern fish abounding in Icelandic waters, but rarely found south of Lowestoft. Some of us have eaten this most repulsive-looking fish under the aristocratic name of " rock salmon " by which it is described in the trade. Owing to its forbidding appearance it is never exposed on the fishmonger's slab in an intact condition, but headless and ready skinned. Few fishes have a more powerful dentition, for with its teeth it

can break up the largest of whelk shells, and make short work of a full-sized lobster or even crab. Like all blennies, it is very pugnacious and has been known to attack persons wading at low-tide.

The Common Blenny or Shanny, *Blennius pholis*, is a miniature edition of the Wolf Fish ; and although seldom attaining a length of more than 6 inches is even

THE WOLF FISH.

more aggressive than its huge northern relative. It bites with extraordinary viciousness when handled, and in the aquarium is sometimes apt to be a nuisance. It bites at everything it sees—the gill-plumes of worms, the eye-stalks of crabs, the antennæ of prawns, and the tentacles of molluscs and anemones. Normally it feeds principally upon acorn-barnacles, nibbling their

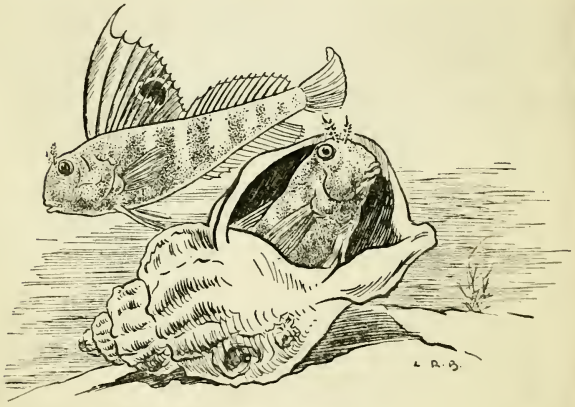
hard, sharp-edged shells from off the rocks. It enjoys the sparrow's perky temperament, and insinuates itself into all sorts of retreats such as holes in the top of harbour piles, or crevices high up in the rocks that may remain uncovered at low-tide. In such situations it may be stranded high and dry for several hours at a stretch without apparently experiencing the slightest inconvenience. Indeed, it will often leave its hole and deliberately crawl about upon the rocks. Although a born bully it is a good parent, and in May and June keeps ceaseless vigil over its eggs which are deposited in layers on the underside of some overhanging boulder.

The Tom-pot Blenny, *Blennius gattorugine*, is largest of the blennies, and is rendered conspicuous by a pink fringed tentacle, like a little cockscomb, situated over each eye.

The most striking member of the genus is the Butterfly Blenny, *Blennius ocellaris*, in which the very large dorsal fin is decorated with a large black eye-spot surrounded by a white ring. Its eggs are usually deposited in whelk shells, in which the male takes up his quarters as soon as they are laid. When thus mounting guard, the little fish looks like a sort of maritime bulldog ensconced within its kennel.

The Butterfish or Gunnel, *Pholis gunnellus*, is a small blenny that has become so elongated as to suggest an eel which it fully equals as regards slipperiness. The name " nine-eyes," by which it is sometimes known,

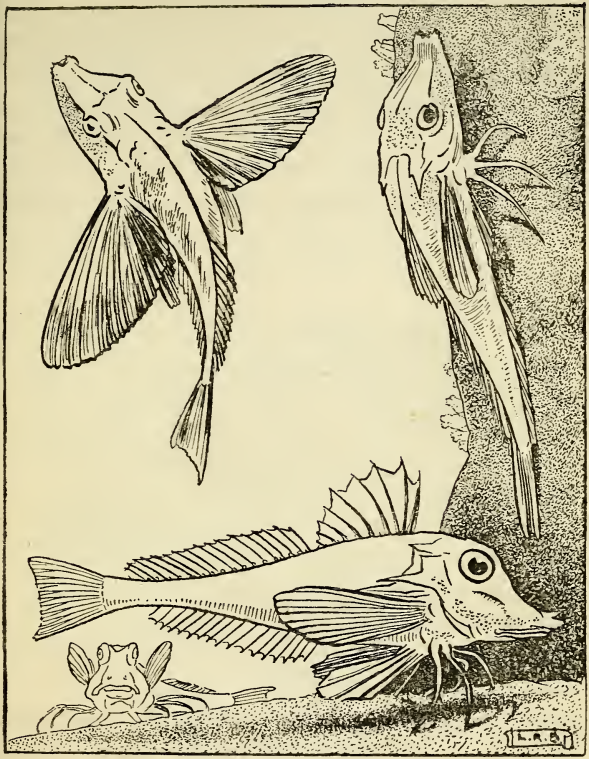
is derived from the row of eye-spots ornamenting the dorsal fin. Like the true blennies, it is commonly found under stones, but is not adapted for " rock hopping," having a deeply compressed body and very small pectoral fins. Whereas in the majority of fishes which take special care of their eggs or offspring, it is upon the male that the family cares chiefly devolve, in



Butterfly Blenny.

the butterfish it is in the female that the nursing instinct is developed, and the eggs which form a globular mass are incubated by the mother coiling her body around them.

The Gurnards, which have aptly been described as the butterflies of the sea, have huge pectoral fins resembling the wings of a butterfly, and the resemblance is



GURNARDS.

rendered the more obvious in the breeding season when they glow with a vivid metallic lustre. Their large conical heads are more or less completely armoured

with limy plates which may extend to the body. Another striking peculiarity is the development of the breast fins, which have the first three rays free. These rays can be used like the legs of a crab for walking about, and in the aquarium the fish may be observed crawling over the sand or even rocks in a manner suggestive of a crustacean. All are capable of emitting grunting sounds when taken from the water, the sounds being caused by a sudden contraction of the air-bladder.

The Sapphirine Gurnard, *Trigla hirundo*, is the largest species, sometimes measuring 2 feet in length, and weighing 14 lb. The brilliant tints of its enormous pectoral fins make a most beautiful display in the aquarium in which it may thrive for a considerable period.

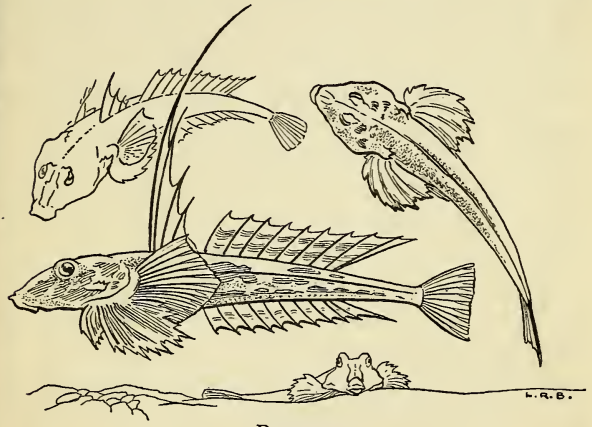
The Bullheads include a number of small inshore fishes with large heavily armoured heads and big fan-shaped breast fins. They rely for safety, however, chiefly upon mimicking their surroundings, and the visitor gazing into their tank at the Zoo, which contains nearly a hundred specimens, will sometimes have difficulty in detecting their presence.

The Common Bullhead, *Cottus bubalis*, which abounds on rocky shores, lays its eggs in circular masses on the underside of stones. They are protected by both parents who aerate the water surrounding them by fanning with their large fins. The young fish when they hatch are very small, and their tiny glassy

bodies display the internal organs in action with the greatest clarity.

The Pogge or Armed Bullhead, *Agonus cataphractus*, has a quaintly shaped angular head and a perfect beard formed of barbules.

The Dragonet, *Callionymus lyra*, a brilliantly coloured fish suggesting the gurnard in shape, is fairly



DRAGONET.

common on sandy shores, harmonizing perfectly with the sand wherein it hunts for the small molluscs and worms upon which it lives. During the breeding season it sparkles with flecks of vivid gold, blue, green, and lilac. In the male—a much larger fish than the female—these patches of colour may be enlarged until they meet, assuming vivid bars. Its eye is a veritable

jewel, whilst the first dorsal fin is developed into a huge crest nearly as large as the remainder of the fish.

The Marine or Fifteen-spined Stickleback, *Spinachia vulgaris*, the only stickleback that is entirely marine, is an elongated golden-brown fish measuring up to 6 inches in length. It is popular amongst those that keep marine aquaria for the reason that not only is it a very graceful creature thriving for many months in captivity, but also because it is a scavenger and can be introduced into tanks with less greedy inhabitants of the ocean, in which it will clear up all the rejected food. It makes curious nests, which are the work of the male fish only. The nest measures 6 to 8 inches in length, and is composed of seaweed interwoven by threads secreted by the kidneys. On its completion the male entices the female to enter to deposit her eggs, using every possible device to induce her to do so. In the frequent event of his invitation not being accepted he will eventually resort to force, and, seizing his " intended " by the fins or tail, drag her after him into the nest. The eggs having been laid, the mother departs and the father keeps a vigilant guard over them and the young after they are hatched, defending the nest and its contents with great ferocity from the attacks of other fish.

The Angler, *Lophius piscatorius*, is an interesting fish rarely seen in the aquarium. Specimens have, however, lived for short periods in London, Plymouth, Naples, and New York. The angler-family is a large

one distributed throughout all seas, cold as well as warm, deep as well as shallow. All lure their prey into their mouths by means of a number of fishing-rods evolved from the first few spines of the dorsal fin, which carry baits in the form of flaps of skin ; and by wriggling these entice the small fishes upon which they live. The prey once within reach, the cavernous mouth is opened and the sudden inrush of water carries the victim into the interior. Although brought to market in vast quantities, owing to its unprepossessing appearance, the angler, like the wolf fish, is seldom seen in its entirety by the public. No creature is better endowed to make the most of its environment. The angler being a bottom-feeder, his eyes, like those of the skate's and turbot's, are set on the top of his head. The sides of the body are beset with a vast number of skinny appendages, perfectly resembling fronds of weed, thus rendering the fish all but invisible, and so fulfilling one of Sir Isaac Walton's golden rules, namely that the successful angler must as far as possible practise the " gentle art " of concealment. The angler digests its food very slowly and the longshore fisherman often does not scruple to transfer fish from its stomach to his stall or counter.

In the ocean abyss, where all is wrapt in impenetrable darkness, the " lures " of the anglers that inhabit those waters are developed into luminous organs. One species of angler is remarkable for the disparity in the size of the sexes, the tiny male appearing to be a mere

parasite when clinging to his bulky bride. Not only is he carried about by her, but eventually becomes grafted to her, deriving nourishment from her blood-vessels.

The adult angler, which is generally regarded as a lumpish brute, commences life upon the waves' crest as a veritable butterfly. It is hatched from one of half a million eggs, the spawn covering one-tenth of an acre of water. The young fish soon acquire the swollen head of its parents, and the graceful fins degenerate into stumpy limbs only capable of dragging the angler over the sea-floor where he relies upon concealment and cunning for a livelihood.

The Cling or Sucker-Fishes, *Lepadogaster*, are all of small size and feeble movement. They are common around our coasts, where they lurk beneath stones, securely anchoring themselves by the powerful oval-shaped suckers formed by a fusion of the breast fins. These little fish are pinkish in colour and usually bear two dark-blue spots on the sides of the body. The sucker lays its eggs under stones or within shells, where they are guarded—as is usual in fish society—by the male.

It is possible to keep a number of tropical marine fish in the aquarium. The difficulties of importing them are, however, sufficiently great to give the aquarist cause for congratulation upon every specimen that he is able to transfer from lagoon or coral reef to the tanks of a northern aquarium. The water in the travelling tanks which must be kept at the right tem-

perature has to be aerated and kept in constant circulation throughout a long voyage, if success is to be achieved. Naturally only a few species, and those mostly of moderate size, are at present shown in our aquarium where they are exhibited among a realistic setting of shells, sponges, and corals. Against the dead coral branches of their tank the fish are more conspicuous than they would be in a state of nature where in the sun-drenched waters of the coral reef their glowing tints are less obtrusive, and more protective.

A fairly hardy and very beautiful Coral Fish is *Amphiprion percula*, which hails from the East Indies. It is of a vivid orange ground-colour barred with broad light-blue bands, whilst the bands and fin-margins are edged with black. The scenic effect of a shoal of these fishes swimming against a background of blue-green water must be seen to be fully appreciated.

This coral fish, being unarmed and of a timid disposition in its native waters, elects to spend most of its time within the cavity of a giant anemone, *Discosoma*,—a gaudy cœlenterate measuring over 4 feet in diameter—and a stick or other weapon thrust into the mouth of the anemone invariably causes one or more of these fish to emerge in a nervous flutter. The most extraordinary feature of this strange combine lies in the fact that the anemone apparently lives solely upon the excrement of the coral fishes. There is an opposing theory, some authorities asserting that the specially vivid colours of these fish attract other

fish within the range of the anemones' stinging cells. Post-mortems on the anemones have, however, revealed no other forms of nourishment than the waste products of their guests. No net or hook is required to capture these fishes for the aquarium. A native diver is employed. He swims to the sea-bed and just grabs a handful of anemones in each of which a coral fish is enclosed! Normally the fish live upon minute crustacea, molluscs, etc. At the Zoo they thrive upon a diet of chopped mussels, previously boiled to sterilize any harmful bacteria that may be present, horse's heart, *Daphnia*, blood worms, etc.

Another Coral Fish, *Dascyllus aruanus*, which is exhibited in the aquarium is jet-black in colour, marked with broad white bands which encircle its face in the manner of a bandage.

The Argus Fish, *Scatophagus argus*, of Eastern Asia, which owes its name to the staring "eye-spots" that emblazon its gold and green sides, is a scavenger haunting the mouths of rivers. It is equally at home in fresh as in salt water. Specimens living in the Zoo aquarium grew from a length of 2 inches to 5 inches in the course of only six months.

The family of Ball, Puffer or Globe Fishes, *Tetrodontidæ*, is represented in most tropical or semi-tropical seas and estuaries. The outstanding feature of these sometimes elongated fishes is their power of inflation which is achieved by the distention of their interior with either air or water, when they become globular

in shape. In some the skin is fairly smooth, whilst in others it is covered with a mass of erectile spines. When inflated with air these fish float on their backs and drift with the tide, those endowed with spines being perfectly safe from attack. When returning to their normal condition the fish expels the air through the mouth and gill-opening with such force that a loud hissing noise is produced, audible at a considerable distance. The members of this strange family which do well in the aquarium, becoming very tame, are further remarkable in that the front teeth are modified into large cutting plates and by means of them are able to browse upon the living corals, barnacles, and bivalves upon which they exist.

The Puffers are of little economic value, although commanding a certain popularity as curios, as their flesh is highly poisonous. Some of the larger forms are used as footballs by youthful sportsmen in certain parts of the Far East.

CHAPTER III

REPTILES

MILLIONS of years ago the world was ruled by reptiles. They dominated the land and monopolized the seas in which they attained their maximum development. To-day the largest living reptile is but a pigmy when compared with the giant prehistoric forms which are known by their skeletons and footprints.

In this chapter we shall deal only with such purely aquatic reptiles that may be exhibited with success in the aquarium. The list is a short one, including only one member of the crocodile family, the sea-snakes, and the turtles.

The crocodile in question is the olive-brown Marine Crocodile, *Crocodilus porosus*,—a man-eater—which attains a length of over 20 feet and a weight of nearly a ton. It infests the whole of the Indo-Pacific region and unlike all other crocodiles and alligators only completely leaves the water in order to lay its eggs. The family cares having been cast aside, it is once more free to roam the oceans, and only returns to " terra firma " the following year in order to bring yet another batch of youngsters into the world. Whilst some crocodiles

and most alligators become tolerably tractable in captivity, the marine crocodile remains constantly savage and aggressive. It makes a striking aquarium exhibit, especially at feeding time, when it falls upon its food with incredible ferocity, tearing it to pieces with violent contortions of the body.

The Sea-Snakes, which are very abundant in all the tropical seas of the Eastern Hemisphere, are rarely shown in captivity owing to their delicate constitutions, and the difficulty of transporting them long distances in the living state. Two fine specimens of the species *Enhydrina valakadien* are at the time of writing thriving in the Zoo aquarium. These serpents, which are very poisonous, but not at all aggressive, are so perfectly adapted to an aquatic life that they never attempt to come ashore. The body of a sea-snake is much compressed, especially the tail, which is paddle shaped and forms a fin-like appendage of great service in swimming, forcing the creature through the water at a great pace. The end of the body is prehensile, and is employed by the reptile not only to anchor itself securely to weeds, corals, etc., but also to hold its victim until the poison injected has had time to take effect. The nostrils are valvular and are situated on the top of the head. The colour scheme is similar in most sea-snakes, taking the form of bands of olive or black and yellow, a ringed pattern which is protective like that of a tiger or zebra, the bands helping to break up the contour of the body of the snake as it

lies amongst fronds of seaweed in wait for its prey.

These sea-snakes have many enemies, and are devoured with impunity by sharks and sea-birds, the latter having been observed to take the snakes to the mast-head of a passing vessel, and there beat the reptiles to death with feet and wings, following the tactics of the Secretary Bird.

The reptiles that are most attractive in the aquarium are the marine turtles which at the Zoo are represented by the Green Turtle, *Chelonia mydas*, the turtle inseparable from the civic banquet, the Loggerhead Turtle, *Thalassochelys caretta*, which is likewise edible, and the Hawksbill Turtle, *Chelonia imbricata*, from which the tortoise-shell of commerce is obtained. All do well in the marine aquarium provided they are kept at a fairly high temperature (70° F. to 80° F.) and provided with plenty of lettuce and fish. These and all the true marine turtles are entirely aquatic, never venturing ashore save for the purpose of egg-laying. The eggs, which resemble ping-pong balls in size and shape, are buried in the sand, where they are left to their fate. In the course of about four months the little turtles emerge and under cover of night scuttle down to the sea. If they successfully run the gauntlet of the monkeys, racoons, and various large birds awaiting them, they launch themselves upon the waves, where they risk the attack of a host of marine animals. It will be appreciated that the casualty list is a heavy one, and it has in fact

THE TURTLE TANK

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been calculated that out of a normal clutch of 120 eggs only two or three turtles attain maturity.

In the aquarium turtles are seen at their very best. There, amid a background of corals and tropical shells, these lumpish monsters positively " flit " through the water with a movement of their huge flippers far more suggestive of flight than of swimming. The swallow may be swifter, but is certainly not more graceful than a turtle in his native element. Turtles are captured for market—and aquarium—in various ways. They may be caught when coming ashore to lay their eggs, netted, or harpooned. In the West Indies two very remarkable, and at the same time picturesque methods of capture are in vogue. The first consists of a highly skilled negro-fisherman leaping from the collecting vessel and grappling with the turtle in the water. By sheer skill, strength and daring he brings the turtle to within easy reach of the ship, where it is hauled on board. The second method is a still stranger one, as it relies upon the fish known as the " shark sucker " for success. The fish is held in leash by a long line and cast adrift in a locality known to be inhabited by the turtles. It soon selects one, and attaches itself to it with extraordinary tenacity by its large sucking disc, which is situated on the upper surface of the body. It is then, along with the turtle, heaved on board.

The term to " turn turtle " is a simile for helplessness, but curiously enough the best way of keeping a turtle alive for any length of time out of water is to turn it on

its back. A glance at the creature's anatomy will make the reason clear. The under-shell is so soft compared with the upper portion that if the turtle's great weight were imposed upon it for long, the internal organs would suffer such compression that death would speedily ensue. In a great body of water, of course, the " dead weight " is at once relieved, and the aquarium turtles may often be seen resting on the tank floor with their fore-flippers crossed upon the breast in a ludicrously human fashion. This and other characteristic poses are suggested in the illustration.

The brain of a turtle is feebly developed, and would appear to be of small consequence. The following story, however, seems to prove that the turtle's brain is at least capable of connecting cause with effect. Some years ago the Amsterdam aquarium authorities were faced with the position of having more specimens available than they could conveniently accommodate, —a state of affairs at once trying as well as gratifying. The cause of the dilemma was the unexpected arrival of a large consignment of mullet. It was finally decided to " chance them " with a number of turtles. To ensure the mullet at least an hour or two of life they were introduced to the turtles a few at a time, the water being violently agitated the while, thus diverting the turtles' attention from the immediate prospects of a meal. As was the intention, the turtles apparently associated the mullet with the uproar and splashing, and regarded them with awe. At any rate they left

them severely alone, although they shortly afterwards devoured other fish placed in their tank for the purpose. The mullet remained unmolested in the same aquarium with the turtles for some months, although any new mullet introduced were eaten. At a later date, however, it was found possible to give the fish a tank to themselves. The effect upon the turtles was at once apparent. Deprived of their tank-mates they refused to feed,—moped in fact—until their health became a matter of grave concern. The choicest foods failed to revive their former gaiety. In desperation the mullet were reintroduced, and from that time onwards there was no happier tank of turtles ever shown to the public.

PART II

THE FRESH-WATER AQUARIUM

CHAPTER I

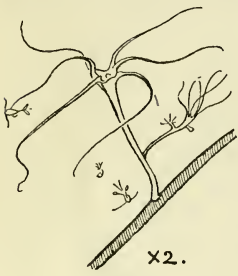
INVERTEBRATES

THE invertebrate animals of our fresh waters, although less in evidence than their marine relatives, are sufficiently numerous, both in number of species and individuals, to " people " every pond and river with a wealth of life. Every stagnant pool is a miniature ocean ; every patch of scum or weed a Lilliputian jungle. The majority of the principal groups of marine invertebrates have numerous representatives in pond or stream, and their numbers are augmented by a host of insects which spend their larval period under water. To enumerate all or nearly all the lower forms of pond life within the compass of a single chapter, or even volume, is obviously impossible. The enthusiast will find the life-cycle of any of them sufficiently intriguing to beguile all his leisure hours, —and more. The average amateur aquarist will value the smaller fresh-water invertebrates chiefly in accordance with the manner in which they minister towards the well-being, or otherwise, of his fish. For the guidance of such this chapter has been compiled.

Whilst the various algæ that appear in the tank must always be kept in check lest they get the uppermost of

the more valuable plants, they nevertheless have their merits, since they harbour a wealth of minute life, animal as well as vegetable, which is indispensable to young fish.

Our only fresh-water Sponge, *Spongilla fluviatilis*, covers the banks of the Thames and other rivers, and is specially plentiful on the timber-work of locks. It increases, as explained when dealing with the marine species, by continual budding ; forming large branches of vivid green colour. These branches may be artificially divided up, when each portion will form the nucleus of a separate clump. Conversely, small portions planted close together may unite to form a single mass. Much aeration is needed to keep the fresh-water sponge in a thriving condition, as the water continually circulates through the small apertures of the sponge and escapes through larger ones which are situated on the summit of conical projections.



HYDRA.

The principal fresh-water polyp is the Hydra, which is known in this country by three species that differ from each other chiefly in colour and the number of tentacles. This diminutive relative of the sea-anemones is named after the many-headed monster slain by Hercules, owing to the fact that if a hydra bud is separ-

ated from the parent stock others quickly take its place, whilst the severed bud itself will give rise to others. The creature further reproduces by the dissemination of spores, so that it multiplies with extraordinary rapidity. The hydra's body is long and slender and surrounded by six or more tentacles that spread out in all directions. As in the case of the anemones, if molested the tentacles withdraw within the main structure of the body which shrinks into a rounded insignificant mass. In the aquarium the hydra should be isolated, for owing to their carnivorous habits and great fecundity, they are a menace to newly-born fish and other small inhabitants of the tanks.

The most conspicuous of our fresh-water worms are the leeches. They are abundant in stagnant as well as running water. One kind, the Medicinal Leech, *Hirudo medicinalis*, which attains a length of over 6 inches, is farmed on the Continent. Although no longer cultivated in England, it is still imported and used by the " profession " in this country in greater numbers than is generally supposed. The body of a leech is soft and elongated, and, like that of a typical worm, composed of numerous segments. At the foremost extremity is a large circular disc in which is situated the mouth by means of which it can firmly attach itself to inanimate and living objects. Leeches, before sucking the blood from the bodies of their prey from which they derive their nourishment, first inflict a wound with the sharp saw-like teeth with which their mouths

are provided. They are first-class swimmers, progressing through the water by flattening their bodies and contracting the muscles, when they assume a flat ribbon-like shape.

The medicinal leech is a quite handsome creature and makes an attractive aquarium exhibit. It is dark green in colour with six orange bands along the back. A large specimen is capable of consuming ½ oz. of blood at a single meal, after which it will swell to more than double its normal size.

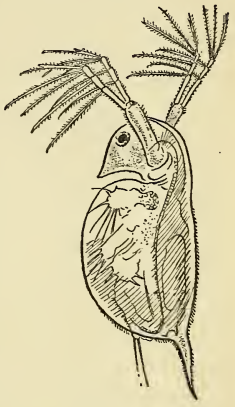
Allied to the aquatic worms are the microscopic Rotifers or Wheel Animacules, so called because of the incessant motion of the numerous hairs situated on the lobes of the front end of the body which present the appearance of a revolving wheel. These lashing hairs produce currents of water which sweep the food particles into the mouth.

The head end of the body of these transparent creatures is often much broader than the opposite extremity which is usually anchored to foreign bodies of different kinds. Female rotifers are much more numerous than males. They have a complicated digestive system, including a gizzard in which the food is crushed, whilst in the males there is no digestive tube.

Some rotifers can be kept dry for comparatively long periods, and will resume activity whenever they come in contact with water.

The small fresh-water crustaceans are amongst the aquarist's greatest assets. The so-called " Water flea,"

Daphnia pulex, swarms in most ponds and ditches during the summer months, and is sometimes so abundant that the water is tinged a rusty red,—the colour of its transparent body. No chance to collect these little crustaceans should be missed, since they form the best of all food for small fish, and are easily cultivated. The "farm," which needless to say is best kept out of doors, can consist of a large tub or bath well carpeted with mud, rotten leaves, and other decaying matter. The tank should, of course, not be allowed to become over-crowded, as the creatures take up the oxygen of the water as do other aquatic animals. The bivalvular carapace of *Daphnia*, which is so transparent that the whole of the internal organs are distinctly visible, somewhat resembles the shell of certain bivalve molluscs, and terminates in a prominent beak. *Daphnia* has four to six "gill" feet, large branched antennæ which act as organs of locomotion, and very strong jaws, armed with spines.



THE SO-CALLED "WATER FLEA" (*Daphnia pulex*).

The female "water-flea" is more than double the size of the male, which it outnumbers by about a million to one. The eggs are retained within the female and

the young are almost perfectly formed when they emerge.

The Cyclops, or to give it its full name *Cyclops quadricornis*, is another common fresh-water crustacean, so called because it has but a single eye like the giants of Greek mythology that gave Ulysses so much trouble. Like its larger relative, *Daphnia*, which it resembles in many respects, it is greatly appreciated by all fish, specially young ones. The female is a conspicuous object when carrying her eggs, which are packed in two pear-shaped sacs, one on each side of the body.

The Fresh-water Shrimp, *Gammarus pulex*, greatly resembles the common sand-hopper in appearance. It is very abundant in many rivers and streams and is highly appreciated by most fish, especially salmon, trout and char. It feeds on decaying matter, both animal and vegetable, and is a useful creature in the aquarium, as apart from providing food for the more valuable exhibits, it acts the part of a scavenger.

The Crayfish, *Astacus fluviatilis*, an inhabitant of clear gravel-bedded streams, well deserves a tank to itself, as it is a miniature lobster possessing all the entertaining habits of that popular crustacean. It is well to keep but a single pair in the same tank, thus eliminating all serious strife. Comfortably housed in a three-gallon tank, they will require no other " furniture " than some clean river sand or gravel, and a number of small flower-pots laid upon their sides in which they will spend most of the daylight hours.

Their tank should be a shallow one, not more than 6 inches in depth—and the water should be kept in constant circulation. Crayfish will eat almost anything, and all being well will periodically present the opportunity of observing that wonderful phenomenon—the casting of the shell. The tank must be kept covered, since its inmates are given to wandering, and unless restrained may cause embarrassment by appearing where and when not wanted.

Spiders possess characteristics in common with certain crustaceans. One of our native spiders, *Argyroneta aquatica*, is purely aquatic, and although an air-breather like its web-spinning brethren of the garden, elects to spend its life under water. The air-breathing is made possible by the fact that the creature is covered all over with fine waterproof hairs which hold the air in suspension until absorbed. It can remain below the water for hours on end, where it works assiduously at the construction of a soft, silky, cup-shaped cocoon having an opening on its underside. Into this opening air bubbles are introduced, each bubble being brought separately from the surface and placed into the sac until it is completely inflated. Within this miniature diving-bell the spider lives, dining upon such small animals that it can capture. The family is reared in this cocoon, in a second, and entirely separate chamber, constructed by the female, and placed by her within the main structure.

The Insects which spend some parts of their exist-

ence under water number many hundreds of species. The gnats that spoil our night's repose, the great flying-beetles that dash into the lamp, the caddis and may-flies that supply the fisherman with bait, the gaudy dragon-fly that delights us on a midsummer's day,—these and many more can be reared in an aquarium of even the jam-jar variety. Great caution must be exercised in associating the various insect larvæ with fish,—or even each other. All the vegetable-feeding forms may be safely introduced with fish too small to engulf them. The carnivorous species must be isolated, or trouble will ensue.

Dragon-fly larvæ, if given private apartments, and are sufficiently well fed to prevent them becoming cannibals, will in due season emerge as perfect insects. In nature they live at the bottom of ponds, patiently waiting to pounce upon and devour any animal they are capable of overpowering. When about to attack they uncoil a strange weapon which covers the front of the head and represents the lower lip. This animated mask when fully protruded exceeds the length of the body. It is armed with a pair of pincers and acts not only as a lip, but also as an arm to seize its prey.

Their tank should be supplied with plant stems rising well above the surface. The pupæ will climb up them on reaching maturity and there make the last great change—one of the most fascinating spectacles the aquarium has to offer.

The larvæ of the Caddis flies are eminently suited

to small aquaria. The insects spend their " caterpillarhood " at the bottom of ponds or streams, where most forms construct tubular houses from shells, gravel, sticks, etc., wherein to conceal their soft and defenceless bodies. They will, if provided with coloured beads or sequins, use such material with novel and ornate effects. The instinct of orientation in these larvæ is very remarkable and they will nearly always return to their own homes if expelled, even when replaced in the midst of a large number of empty cases of similar appearance. The eggs of the caddis fly are hatched during the summer months, and the immature insects remain in the larval stage until the following spring or summer.

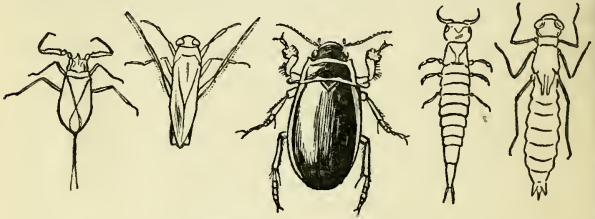
The scarlet worm-like larvæ of the midges of the genus *Chironomus* are to be found in the mud or decomposing vegetation of most ponds. Commonly referred to as " blood worms," these creatures are highly esteemed as food by a large number of fishes.

Special care should be taken to restrain water beetles as they are nearly all night-flyers, and may not come home to roost, but at dawn resort to another aquarium containing fish.

The powerful carnivorous Tiger Beetle, *Dytiscus marginalis*, will attack creatures several times its own size. Its upper surface is dark brown in colour, whilst the thorax is bordered with yellow. The larva has an elongated segmented body tapering at the tail, which terminates in a pair of fringed appendages. The head,

which is large and roundish and furnished with a pair of long slender jaws, is joined to the thorax by a narrow neck.

The Great Beetle, *Hydrophilus piceus*, which is our largest native water beetle, attains a length of an inch and a half. As it is a vegetarian it may be kept in the same aquarium with fish. From the Tiger Beetle, which it superficially resembles, it may be distinguished by its larger size and shorter mandibles and antennæ. The body is brown or olive above, but appears silvery



CARNIVOROUS WATER BEETLES.

Water Scorpion. Boatman. Tiger Beetle. Larva of Tiger Beetle. Pupa of Dragon-fly.

below, the silver colour being due to a layer of air particles which remains attached to the downy hair of the beetle's undersurface. The female is provided with a spinning apparatus, situated at the extremity of the abdomen, by means of which she spins a cocoon on the surface of the water, attached to the stem of some aquatic plant, and in this receptacle she lays her eggs. The larva of *Hydrophilus* is somewhat shorter and more bulky than that of *Dytiscus*.

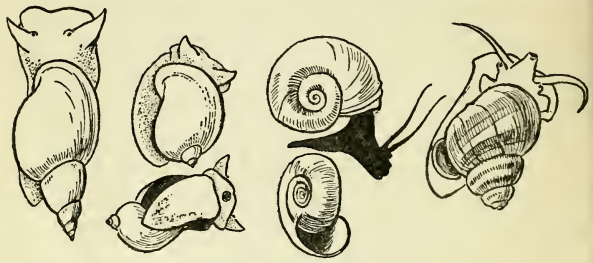
The Water Boatmen, represented by several species,

are extremely abundant in all ponds and may be observed during the summer months swimming on their backs, just below the surface of the water. They are admirably adapted to aquatic life, for their stout bodies are shaped like inverted boats and their flattened hind limbs are fringed with hairs that stand out in the position of oars. They have a strong beak with which they can inflict quite painful wounds to the human hand and kill almost any small aquatic animal. The air supply of the boatman is carried in its wings, and it therefore has to return to the surface for replenishment at frequent intervals. The larvæ resemble the perfect insects, but have no wings.

Some remarkable if somewhat gruesome experiments have in recent years been conducted in the aquarium of the Biological Experimental Institute in Vienna, where the decapitated heads of living water beetles have been successfully transplanted to the bodies of other insects. The author himself had the privilege, when visiting Vienna some years ago, of seeing an aquarium in which beetles with *Dytiscus* bodies and *Hydrophilus* heads were actively swimming about and diving under water. The heads were cut off with a pair of sharp scissors and merely cemented to the bodies with the exuding fluid, no suture being required. According to the officials at the Institute, the insects so operated on are controlled by their new heads and not by their bodies. Female beetles provided with male heads were said to develop male

instincts and to court normal females, whilst males with new female heads were stated to become passive.

Similar experiments were conducted on two species of boatmen beetles, *Notonecta glauca*, which is uniform brown in colour, and *Notonecta marmorata*, which is brown with black reticulations. When the head of the latter was transplanted on to the body of the former it assumed, within a few weeks, a marbled pattern.



USEFUL AQUARIUM SNAILS.
Limnæa stagnalis. Limnæa pereger. Planorbis corneus. Paludina vivipara.

The Molluscs are well represented in fresh-water. Two species, the Fresh-water Limpet, *Ancylus fluviatilis*, and the Nerite, *Neritina fluviatilis*, are inhabitants of fast-running streams and will seldom thrive for long in the average aquarium. Nearly all other kinds, however, do well and are often indispensable to a correct "balance." The univalves figured are good scavengers, addicted to clearing up refuse of all kinds, and keeping the glass clean. The gelatinous egg-masses which are lavishly deposited on the plants during the summer months, apart from affording an

interesting subject for the microscope, are welcomed as food by all manner of fish.

The bivalves such as the Swan Mussel, *Anodonta cygnea*, perform several useful offices in the aquarium. They feed by inhaling water through one of two siphon pipes extracting the organic matter contained, and expelling the purged water by the " exit " tube. Thus they act as filters, and assist in the general circulation of the water. By ploughing up the sand with their big foot and wedge-shaped shell they also help to keep the bottom fresh, dislodging decaying matter that may have become partially buried. Several of our native fresh-water mussels produce pearls,—of a kind—whilst the Painter's Mussel, *Unio pictorum*, is remarkable in that it acts as a nursery for the young of a certain carp.

The life-histories of our native fresh-water invertebrates have engaged the attention of many professed scientists throughout the past century.

A small and unpretentious beginning, no farther away from home than the nearest reservoir or water trough, may well lead the amateur on to make further incursions into the wonders of the water world, which will reveal to him a wealth of romance and beauty hitherto unsuspected.

CHAPTER II

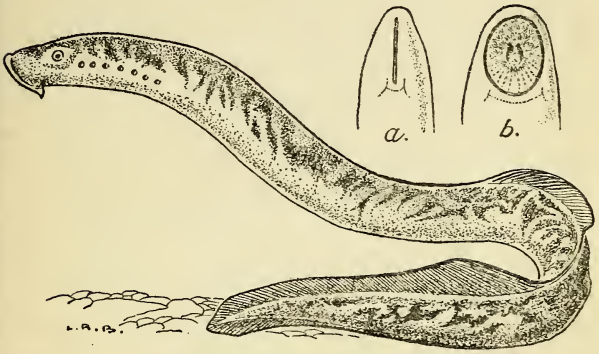
FISHES

OUT of the many hundreds of species of fresh-water fishes, only a quite insignificant number have been kept in aquaria. The cold-water forms are naturally better known than those emanating from tropical streams and rivers, but in spite of the difficulties and dangers attending the collection and safe transport of the latter, quite a number have been kept in captivity and acclimatized in this country. To show the tropical fish in anything approaching natural surroundings is obviously impossible, and the visitor to the aquarium must exercise his imagination and picture the majority of the brilliantly coloured forms which he sees on exhibition as living in fever-haunted swamps and crocodile-infested rivers at which troops of antelope, monkeys, deer, and elephants take their evening fill.

In this chapter we shall review the many wonderful fishes inhabiting our own rivers, as well as those living in tropical waters, dwelling upon such as may be seen at the Zoo aquarium.

In captivity the tropical forms will thrive in water at a temperature of about 75° F.

The Lamprey, *Petromyzon fluviatilis*, is a creature firmly imprinted upon our memories as the fish that caused the death of King Henry II. As a matter of fact, lampreys are " not quite " fish, from which they differ in having no transverse jaws, the mouth being circular and suctorial, and no paired fins. Further, they are provided with a peculiar type of breathing



LAMPREY (*Petromyzon fluviatilis*).
(*a*) Mouth closed. (*b*) Mouth open.

apparatus, no scales, and a soft cartilaginous backbone. The suctorial mouths, by means of which they attach themselves to other fish, are lined with concentric rows of sharp cutting teeth, and by means of these rasp away the skin and flesh of their prey. From February to May, according to climatic conditions, the lampreys ascend our rivers in vast shoals, and selecting a gravelly site turn to nest building. This is accomplished by

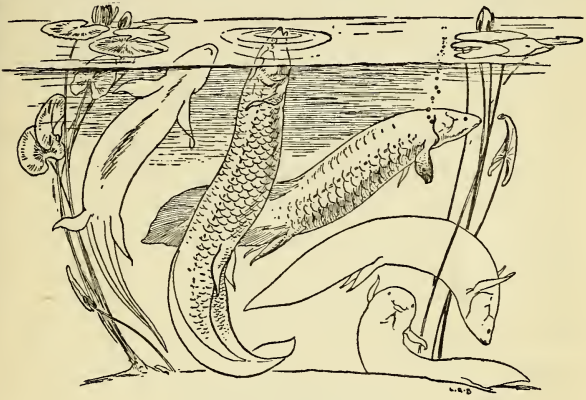
removing large stones from the river-bed in their suctorial mouths until a large trough is formed, and in this receptacle the eggs are laid. The eggs are connected together by sticky threads which collect the sand and grit, at once anchoring and concealing the spawn. The young have at first no visible eyes or mouths. In four years they reach maturity, when they propagate, —and die, so great are the labours involved by the nest building and egg laying. In the aquarium lampreys spend much of their time concealed in the sand, but they are also given to attaching themselves to the glass front of their tank, where their peculiar mouths may be seen and studied to perfection.

The primitive fishes such as the Lung-Fish, the Snake Fish, the Sturgeon, and the Bow-Fins, are amongst the most interesting of the exhibits in the large public aquarium. They swim to-day before a crowd of sightseers as once they swam, with none to observe them save the prehistoric animals which have been non-existent for millions of years.

The Lung-Fishes at one time enjoyed an almost world-wide distribution, but are now confined to the fresh waters of Australia, Africa, and South America.

The largest is the 6-foot-long Australian Lung-Fish, *Ceratodus forsteri*, of which two specimens have for many years been on exhibition at the London Zoo. The air-bladder of the creature is modified to do duty as a lung, a truly beneficent dispensation since the fish lives in the stagnant pools of the Mary River in Queens-

land, where the water in the hot weather becomes foul and unfit for breathing by means of gills. Its movements are very deliberate and in its structure and general behaviour suggests a salamander or huge newt rather than a fish. For long periods it will rest motionless at the bottom of its tank with uplifted head, the body raised upon the bases of its large paddle-



AUSTRALIAN LUNG-FISH.

shaped breast fins. At other times, this lung-fish will slowly swim about the aquarium. After having risen to the surface to fill its lungs with air, a procedure which takes place at intervals of about half an hour, it slowly sinks to the bottom again, its extended fins acting as parachutes. Sometimes when resting on the floor of the aquarium it will rock from side to side in a way which suggests the well-known habit of the giant

aquatic salamanders. The Australian Lung-Fish feeds on both animal and vegetable matter.

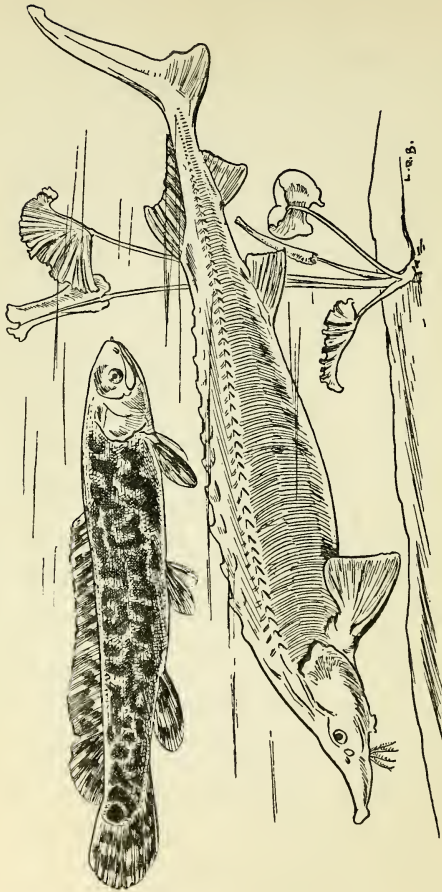
The African and South American lung-fishes are not unlike in general appearance, but the body differs in being more eel-shaped and the fins in assuming the form of long worm-like filaments that are quite useless for swimming purposes. Unlike the Australian Lung-Fish which never leaves the water, both the African, *Protopterus*, and South American, *Lepidosiren*, live entirely out of that element for several months in the year. On the approach of the dry season they burrow some 18 inches into the mud, in which they construct a cocoon lined with a slimy mucus secreted by certain glands. In this chamber, which is connected with the surface by a narrow tube, the fish lie comfortably coiled up throughout the longest drought. Several specimens of the African Lung-Fish, now living in the Zoo aquarium, arrived in the dry state, and the large lumps of sun-baked earth containing the cocoons had to be soaked in tepid water for some hours before it was found possible to release them. In these lung-fish the paternal instinct is very highly developed. In the African the father not only constructs the nest, which takes the form of a large circular hole excavated in the bottom of a pool, but also mounts guard over the eggs when they are laid, aerating them by violently lashing the water with his tail. For the first few weeks of their existence the baby lung-fish resemble tadpoles and are provided with suckers on the under-

surface of their heads, by means of which they attach themselves to the nest.

In the American Lung-Fish the eggs are laid in a subterranean burrow also excavated by the male, and having a total length of 4 feet. *Protopterus* and *Lepidosiren* are both strictly carnivorous. In the aquarium when several of these fish are kept together they are liable to make a meal off one another's long vermiform fins, which, however, grow again in a very short time.

The Snake Fish, *Polypterus*, is another very ancient type of fish, now confined to the muddy rivers of tropical Africa. The scales are hard bony structures fitted together like the tiles of a roof. The body is elongate and the spines of the dorsal fin support several soft rays, which give the impression of a row of little sails. The young on hatching are provided with long external gills like those of newts and salamanders.

Probably the best known of the surviving " primitive fishes " are the members of the Sturgeon family, one of which, the Fresh-water Sturgeon or Sterlet, *Acipenser ruthenus*, of Eastern Europe, is sometimes exhibited in public aquaria. Although but a dwarf compared with the Royal Sturgeon, the sterlet, which seldom attains a length of more than $2\frac{1}{2}$ feet, is an impressive creature. It is heavily armoured from head to tail and ploughs up the river-bed with its pointed nose, devouring the worms, molluscs, etc., thus dislodged. Its flesh is excellent eating, its swim-bladder is convertible into isinglass, its roe affords caviare, and its liver pro-



BOW-FIN AND FRESH-WATER STURGEON OR STERLET.

duces oil. As a result the shoals which annually visit the great rivers of Russia are eagerly awaited by thousands of fishermen, and upon their arrival are attacked with spears and nets amid scenes of indescribable excitement.

Sterlets do well in the aquarium provided they are given cold water and are amply supplied with oxygen. Some specimens still living at the time of writing in Captain Vipan's private aquarium at Stibbingdon Hall have survived forty years of captivity.

Another survivor since a very ancient geological period is the North American Garfish, or Gar-Pike, *Lepidosteus*, which was very abundant in Europe during the Eocene and Miocene periods. It is characterized by a long slender beak and by hard bony scales which form a complete and impregnable coat of mail. The garfish will attack almost anything, and having caught its prey crosswise in its beak turns it round until the head end is in line with its mouth, whereupon the prize is bolted whole. In its method of capturing and devouring the fish it lives on, it in fact behaves exactly as does the slender-nosed crocodile or gharial of India. It is a hardy fish and has been known to live over twenty years in the aquarium.

The last of the primitive fishes to be mentioned is the Bow-Fin, *Amia calva*, a native of the Great Lakes of America. It is an elongate fish measuring up to 2 feet in length, with a long dorsal and a large rounded tail fin. Like the garfish, it owes its survival to

extreme hardiness, unpalatability, and a domineering temperament. Zoo specimens, unlike nearly all other inhabitants of the aquarium, never become tame, and will not hesitate to snap viciously at the hand that feeds them.

During the breeding season we see a softer side to the nature of the male who takes upon himself all the cares of the family. First of all he constructs a large nest by clearing a circular space, several feet in diameter, amongst the rushes, biting some off, and beating others down with his tail. Having supervised the laying of the eggs, he guards them assiduously from the unnatural mother who would otherwise devour them.

The Carp and all the fishes to be referred to hereafter belong to the modern group of " bony fishes," *Teleostei*, which includes thousands of species. In this volume the group is headed by the members of the Carp family, and that for the reason that no other fish hold such a position in the affections of not only the aquarist, but of mankind in general. The birthplace of the carp is, according to tradition, centred in Korea. From thence the fish was introduced into China and Japan, and later to every quarter of the globe. In Japan the carp is associated with every conceivable phase of human life. It stands not only for a religious emblem, but also plays a part in public merrymakings. There it is a theme for the artist, whether in paint, bronze or verse ; a dish for the family board, and a

GARFISH TANK.

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child's plaything. In Tokyo alone thousands upon thousands of huge paper carp-kites float above the roof-tops to celebrate the " festival of baby boys."

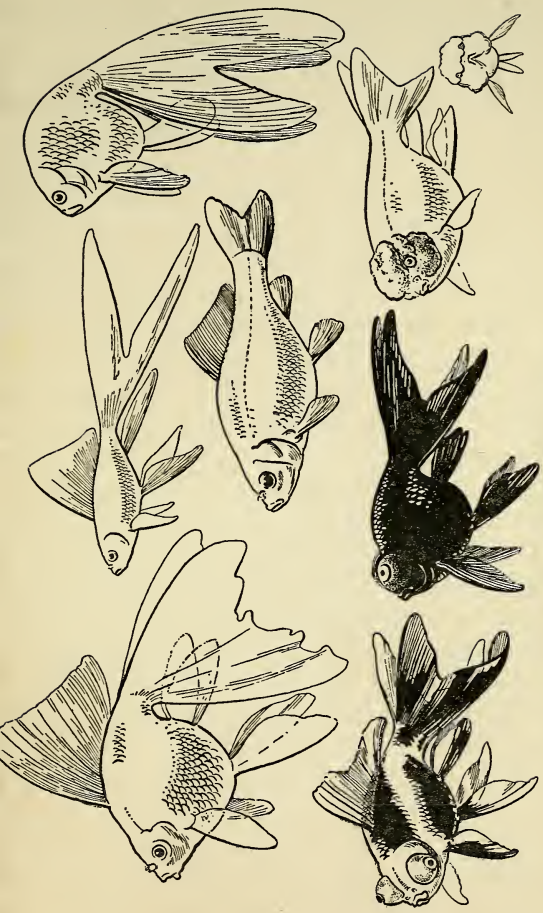
The Common Carp, *Cyprinus carpio*, is a heavily built fish of a dull greenish bronze colour, growing to nearly $2\frac{1}{2}$ feet in length and attaining a weight of 80 lb. It was once much valued in England as a food-fish, and although still popular as such on the Continent, is nowadays in this country only eaten by the Jewish population. The lake at Fontainbleau harbours some enormous carp, stated to be " white with age." Granted that these carp are very old—half a century or more,—their " rime of age " is only to be attributed to fungus which coats them with a dense but unromantic frost.

The Carp has penetrated nearly every portion of the globe in its natural, as well as its unnatural form—the goldfish. It has made its way in the world entirely on its merits, for it is at once the most intelligent and hardiest of all fish. Its brain power is evinced not merely by the tricks that it can be taught or by the readiness that in captivity it gets to know those who tend it, but also by the cunning it displays when confronted with the fisherman's baited hook. With regard to its hardiness, specimens have been known to survive a sojourn in water raised for several hours to a tropical heat, and to live through a prolonged internment in a block of ice. Moreover, the fish can exist out of its natural element for a considerable period, and can make

a twelve-hour trip by post packed in moist weeds, and appear " still smiling " on delivery.

As with many of our domesticated animals, its powers of adaptability have been abused. By interbreeding and selection, varieties have been produced some of which are really captivating, but others, at least in my opinion, are merely repulsive. Tastes, however, differ. The Comet Goldfish, with its long flowing tail, and the elegant Veil-tailed Goldfish, are amongst those that are certainly a delight to the eye. But what shall one say of such monstrous varieties as the Stargazer with its protruding eyes situated on the top of the head, and the Tumbler, a form which cannot swim straight by reason of a carefully cultivated curvature of the spine ? It is comforting to reflect that Nature will have her way, and that a large percentage of fancy goldfish hark back to their old original form. In every brood of " goldfish " a number do not become gold, whilst only one out of a thousand comes up to " show " standard, the remainder reverting to the ancestral type. The Stargazer and Telescope Fish, for instance, all begin life with normal eyes, and only very few inherit the ocular disability which renders them so valuable to the fancier.

The goldfish is easily bred. A pond sufficiently large, with plenty of floating plants and immunity from foes, is all that is required. Given such conditions it will deposit its eggs usually in the spring, in batches of a dozen or two on the surface weeds until it has



VARIETIES OF GOLDFISH.

deposited about a thousand in all. Those eggs that have not been eaten by the parents will, in due course, hatch out into tiny fish-fry each provided with a yolk-sac attached to the underside. In about a month the young fish may be removed to other ponds or tanks well stocked with weeds and supplied with such food as *Daphnia* and *Cyclops*. Failing these, dried and finely ground cabbage or vermicelli may be supplied. Ants' eggs, unless absolutely fresh, have little nutritive value. It is not surprising that a fish so adaptable as the carp should have given rise to many varieties apart from those derived from the goldfish.

The Prussian Carp is a hardy fish distinguished by its deeper and shorter body, and by the absence of barbules on the lower lip.

The Mirror Carp or Leather Carp is a variety of scaleless carp in which the scales are either entirely absent, or scattered over the body in the form of a few large plates which reflect the top light of the aquarium with picturesque effect.

Another member of the family is the Bitterling, *Rhodeus amarus*, a small fish, so called from its bitter taste, inhabiting Central Europe. Owing to its strange breeding habits it makes a most interesting aquarium exhibit. The female is provided with a long tube which serves as an ovipositor, and by means of it shoots the eggs into the inhalent siphon of the pond mussel, *Unio pictorum*, the mollusc's respiratory current of water providing the necessary oxygen for the ova.

There is a curious system of " give and take " between the mollusc and the fish, the baby pond mussels usually spending one of their larval stages attached to the bitterling.

The genus *Barbus* embraces an enormous number of fish. It includes such diverse forms as the giant Mahseer, *Barbus mosal*, of India, a sporting fish attaining a weight of 250 lb., the Common Barbel, *Barbus barbus*, of our rivers which grows to a maximum length of 3 feet, as well as a vast number of small forms, inhabiting the rivers and streams of tropical Africa and Asia. Many of these small warm-water barbels are very hardy and in aquaria show off their brilliant silvery or golden hues to advantage.

The Common Barbel is immediately recognized by its long curved snout and its horse-shoe-shaped mouth, with two large barbules set almost underneath the head. Barbel swim about in shoals during the summer months, but in winter retire into the mud at the bottom of the river where they lie in a semi-dormant condition.

The Gudgeon, *Gobio gobio*, is a small fish similar in shape to the barbel. It has a predilection for fast-flowing waters, where it lurks amongst the boulders of the stream-bed. Although one of the commonest of European fish, the gudgeon is not known in Scotland.

The Roach, *Rutilus rutilus*, the Rudd, *Scardinius erythropthalmus*, and the more slender Dace, *Leuciscus leuciscus*, are often kept in the aquarium. Although

amongst the most familiar of our fresh-water fish, difficulty is often experienced in discriminating between them. The use of the following key should render their identification easier :—

1. Dorsal fin more or less on a line with the ventral fin :—
   (*a*) Dorsal fin with 7 or 8 branched rays . . . . . *Dace.*
   (*b*) Dorsal fin with 9, 10 or 11 branched rays . . . *Roach.*
2. Dorsal fin far behind the base of the ventral fin . . . . . *Rudd.*

The Dace and Roach are not satisfactory aquarium fish as both are very subject to fungus disease. The more handsome Rudd with its red fins and red eyes is much easier to keep in confinement and has been known to live for over ten years in captivity.

The Golden Orfe is a graceful pinkish-golden fish closely allied to the roach. It is a German product, being a domesticated variety of the Ide, *Leuciscus idus*, and is imported into this country in very large numbers. It is a comparatively hardy fish, suitable for ornamental garden pools.

The lively little Minnow, *Phoxinus phoxinus*, which does not grow to a length of more than 4 inches, does well in the aquarium, and a shoal of these fish makes an attractive exhibit.

The Common Bream, which has a deep and very strongly compressed body, may attain a weight of

18 lb. It swims in large shoals and inhabits lakes and slow-running rivers. It is an ornament in the aquarium where it unfortunately does none too well, large specimens being specially susceptible to fungus disease. The bream frequently hybridizes with the roach, the hybrid fish resembling a slightly deeper roach. Bream and rudd hybrids have also been recorded, but are not so common.

The Loaches are long-bodied fish of small size, practically devoid of scales, and having the lips fringed with a beard of six or more barbules. Their air-bladders are in close connection with their skin and ears, with the result that changes in temperature and pressure are at once appreciated.

The Common or Stone Loach, *Cobitis barbatula*, becomes very restless on the approach of a thunderstorm, whilst the Weather Fish, *Misgurnus fossilis*, is so hypersensitive that it is kept in small tanks in many continental households to play the part of a barometer.

There is no more suitable fish for the aquarium than the large deep-bodied Tench, *Tinca vulgaris*. Its minutely scaled greenish-bronze skin is intensely slimy, a feature which our forefathers were quick to explain in their own peculiar way. The tench was known as the " doctor fish," and it was maintained that its slime possessed medicinal qualities, not only for human beings, but for other fish as well. Like carp, tench hibernate during the cold weather, secreting themselves in deep holes beneath the roots, and in the

banks of the ponds or rivers they inhabit. It happens on occasions that a fall of soil imprisons the fish, and some extraordinary specimens of tench grown to the conformation of their cells in which they have been incarcerated for years, have from time to time been " dug up." Twelve pounds is regarded as its weight limit in this country. A domesticated variety has acquired a colouring similar to that of the golden orfe and is known as " Golden Tench."

Amongst the smallest of fish are those Asiatic members of the carp family known as Zebra Fish from their striped patterns.

The very active small Zebra Fish, *Danio rero*, of the East Indies, which measures barely an inch in length, is a very striking fish, its cream-white body being longitudinally striped with blinding metallic blue. Its minute eggs may, at a temperature of about 75° F., be deposited on the floor of the aquarium, but as both parents are apt to devour them, with the exception of those laid in large vessels thickly planted with weeds, very few ever hatch out in captivity.

The Perch, *Perca fluviatilis*, with its more or less humped back, large spiny dorsal fin and barred pattern, is too well known to need a detailed description. It is common nearly all over Europe and represented by very closely allied species in North America. Sir Izaak Walton described the perch as " a very bold, biting fish," and that is a very apt description of its character. Although sociable, and travelling peaceably in large

Photograph by] [*Neville Kingston.*

COMMON PERCH.

Photograph by] [*Neville Kingston.*

CICHLID PERCH.

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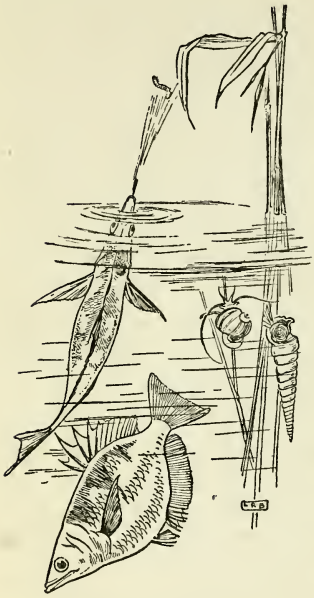
shoals, it is individually very pugnacious and will feed upon almost anything it is able to swallow. It does well in the aquarium and will refuse nothing in the way of food. Care, however, must be taken to prevent it becoming associated with other fish. Its average weight is a pound and a half, although five-pound specimens have been recorded from the Welsh Lakes. About two hundred thousand eggs are laid in March or April and are set in a white gelatinous mass of ribbon-like form, suggestive of a scarf which has accidentally fallen into the water and become entangled in the weeds.

The Ruffe or Pope, *Acerina cernua*, is closely related to the perch, but distinguished by its smaller size, dingy buff colouring, and the arrangement of its two dorsal fins which, instead of being separated as in the perch, merge into one another. It inhabits all parts of Northern Europe, frequenting quiet waters where it swims placidly close to the bottom. It entirely lacks the fire and vivacity of the perch, and in captivity hides away in crevices in the rockwork of its aquarium. For some strange reason this harmless little fish in mediæval times shared with certain other animals a reputation of being in league with the devil, and was in consequence made the subject of a cruel and senseless persecution. The pious men of those times, having enjoyed a protracted orgy of devotion, sallied forth with rod and line to spend the afternoon " corking the pope," a sport which consisted of catching the fish and

then decorating the tallest spine of its dorsal fin with a cork. The wretched creature was then returned to the water, where it afforded much holy mirth by its vain efforts to swim down to the river-bed. The chroniclers inform us that the water might sometimes be seen covered with thousands of these bobbing corks, each one denoting a "pope" doomed to starvation.



Archer or Rifleman.

The perches of the family *Centrarchidæ* are mostly inhabitants of North America. The most beautiful member is the green, blue and orange Sun Fish, *Eupomotis gibbosus*, which is characterized by a scarlet blotch on the gill-covers. It is a very hardy fish and has been bred in ponds in this country.

One of the most entertaining of all tropical aquarium fish is the perch known as the Archer, or Rifleman, *Toxotes jaculator*, a native of the rivers of the East Indies and Northern Australia. It derives its popular

name from its habit of capturing the insects upon which it lives by shooting water at them, and in the Malay Peninsula it is commonly kept in captivity for the display of this amusing habit. Its strongly developed jaws form a spout, through which it suddenly ejects a spray with such force as to bowl over the insect that may be resting on the overhanging riverside vegetation.

The perch-like fish of the family *Cichlidæ* embrace some three hundred species, most of which are confined to Africa and tropical America. They are mostly small fish, rarely exceeding a foot in length, and are remarkable for their brilliant ever-changing colours. Most interesting are their breeding habits. In the spring the newly wedded pair commence house-building by the simple process of engulfing mouthfuls of sand from a selected site, and dumping the sand so gathered some distance away. In time a deep pit is formed in which the eggs are laid. Sometimes several pits are dug and the eggs are transferred in the mouths of the parents from one to the other. Last year a pair of Zoo cichlids were encumbered with an unusually large family, the said family being much persecuted by other fish tenanting the same tank. The parents in consequence were constantly "moving." They took turns in digging out fresh nests, and as each neared completion first the eggs, and at a later stage the young were transferred by the mouthful. In spite of the fact that the building and baby-carrying were

constantly hindered by the interruption from neighbours, the two fishes managed somehow to accomplish their purpose and most of the young were reared. Upon hatching, the infant fish were very carefully guarded, and more or less confined to the nursery. It was a harassing time for the parents, for the babies at an early stage developed a tendency to " stay out late " and had to be brought back, sometimes as many as twenty at a time, in the parental mouth.

In some species both parents share the responsibilities attendant on a family of a hundred or more ; in others one parent only takes charge, the other showing a tendency to feast upon the progeny.

The female Mouth Breeder, *Paratilapia multicolor*, for instance, gathers up the eggs into her mouth as soon as she has laid them, and there retains them, her cheeks swollen to almost cracking-point, until the young emerge. For some weeks after they have hatched the little cichlids on the appearance of father return hastily into their mother's mouth.

The Angel Fish, *Pterophyllum scalare*, although rarely exceeding 10 inches in length is the most spectacular of all aquarium fish. In shape it is much taller than long, and is more compressed than a flat-fish or John Dory. Its extraordinary depth is much accentuated by the vertical bands which extend from the tip of its huge dorsal fin to the bottom of the anal fin. These bands, which appear and disappear suddenly, have the effect of making the tank the fish inhabit

THE ANGEL FISH TANK.

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appear much deeper than is actually the case. The capture of the angel fish is no easy matter, as not only does it inhabit waters infested with anacondas and electric eels, but owing to its highly compressed form is all but invisible when seen from above. The collector, working by the lantern light in the cool of the evening, is only aware of the presence of the fish by its narrow shadow cast upon the floor of the stream. Towards the shadow he directs his net, and by a swift upward movement may—or may not—land his fish. When one adds a swarm of super-mosquitoes to the beforementioned anacondas and electric eels, in addition to a host of other distracting animals peculiar to the Amazon, it will be appreciated that angling for angel fish is by no means an easy or comfortable sport. The angel fish has been bred in the aquarium. Its eggs, deposited on the leaves of plants floating in shallow water, are aerated by a rapid winnowing motion of the parental fins. So violent are the amorous antics during the breeding season that they suggest a duel to death rather than a courtship.

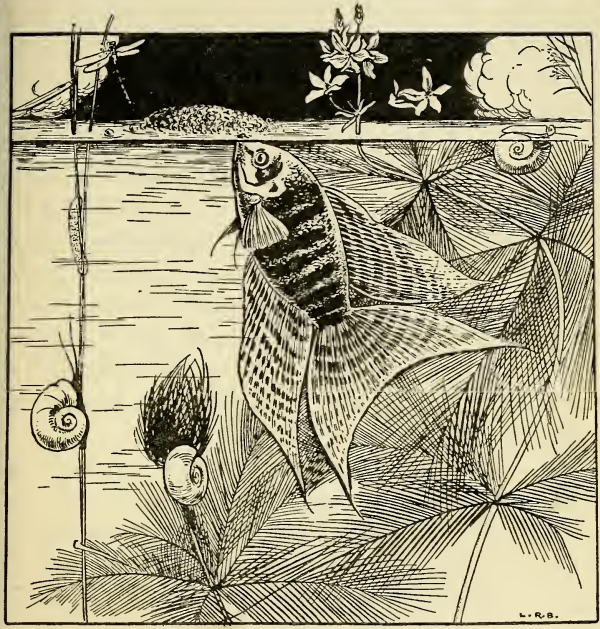
The notable aquarium fish belonging to the families *Anabantidæ* and *Osphromenidæ* are able to breathe atmospheric air, and are provided with an accessory air-cavity situated beneath the gill-covers in which air can be stored for comparatively lengthy periods. Thanks to this air-chamber, some of them can live for several days at a time out of water, and survive when other fish succumb to the drought.

The so-called Climbing Perch, *Anabas scandens*, of tropical Asia, if the reports be true, can not only clamber over the mud and shingle of a sun-dried water-course, and so make his way to the nearest puddle, but can even ascend trees, although why he should perform the latter feat is difficult to explain. In the aquarium he belies the title which has made him famous, for he cannot be induced to climb. The fact remains, however, that he is said to do so in his native land and is well adapted to perform the feat, and to breathe comfortably whilst thus engaged. The climbing is accomplished by means of certain sharp spines set on the gill-covers and also on the fins which are used as climbing irons. By muscular contortions the fish fixes the spines into any convenient crevice and then using them as levers pushes himself forward.

The climbing perch is a hardy fish and can stand extremes of temperature.

The Paradise Fish, *Macropodus viridi-auratus*, is a gorgeously tinted fish, hailing from China, and is not much longer than its scientific name as printed above. When the time comes for family cares the male fish rises to the surface and blows bubbles until a frothy fairy-like nest is constructed. With each puff from its mouth a sticky secretion is extruded so that the bubbles hold together and form a frail yet durable mass. The eggs, as soon as laid by the female, are taken up into the mouth of the male and carefully deposited into the nest. The father then mounts guard and defends the

contents of the prismatic nursery from enemies, of whom the chief is the mother—a lady with infanticidal tendencies. In the building of this "bubble nest," the gills with their ample reserves of imprisoned air



PARADISE FISH.

play an important part, and indeed make the fashioning of the homestead possible.

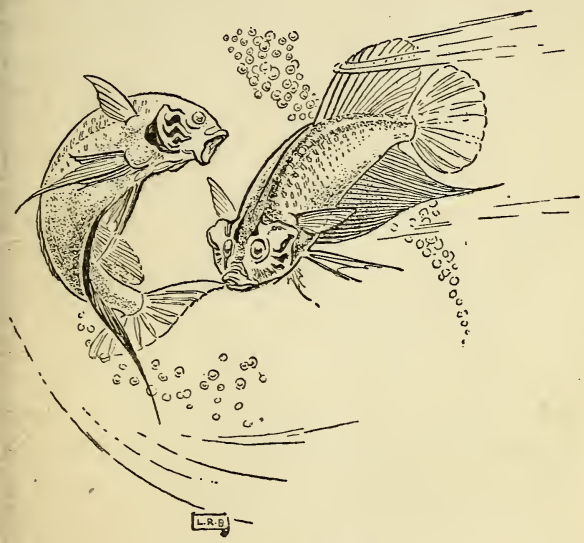
The Gouramis, *Osphromenus*, are also builders of "bubble nests." The group is distinguished by the

peculiar breast fins, one ray of each being developed into a long filament which is apparently used by the fish to feel its way about.

Every creature capable of putting up a fight has been made at some time or other to minister to our blood lust, and the pugilistic gifts of the little Fighting Fish, *Betta*, were early appreciated in the country of its origin—Siam. Enormous fortunes have been lost on horses and at cock-fights, but the Fighting Fish must surely outvie all other creatures in the influence which an animal can exercise over man's instinct for gambling. Until a fairly recent date devotees of these fish fights were wont to stake not only their last coins, but their entire estates and as a final desperate expedient their personal liberty and that of their family. It was in fact a common occurrence up to the early part of last century for a " loser " to undergo several years of slavery to his successful competitor.

The accounts of these fights make romantic reading. The spectators squat, tier upon tier, on cushions or mats round a glass bowl suspended from the ceiling by a rope, into which the two male fighting fish are placed. The rivals, each little more than an inch in length, at once engage. Their fins rise, their mouths open, and their bodies glow with a truly Oriental splendour. From the outset the pace is furious. In a few moments the bowl is a froth of bubbles in which the combatants are all but invisible. A " round " lasts but a few minutes, and so great is the damage

entailed that a fish rarely fights more than once, after which, if he lives, he is relegated to the stud. The excitement created by such fights has been described as quite amazing and by the close of a spirited contest most of the concourse is on its feet.



FIGHTING FISH.

Like the Paradise Fish, the Fighting Fish are bubble-nest builders, and will breed in aquaria of a depth of not more than 6 inches.

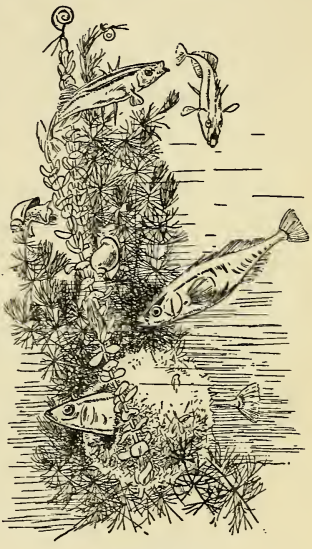
The "tiddler" of the juvenile anglers or Three-Spined Stickleback, *Gastrosteus aculeatus*, is not suited

to the companionship of other fish. It is, however, a great asset in the aquarium, where in the spring its courtship and the care with which it guards the eggs and young may be observed, affording much entertainment. The males, always pugnacious, then become extremely savage, and put on gorgeous tints, their backs assuming a glowing emerald and azure-blue colour, and their bellies a flaming crimson. The prospective husband constructs a barrel-shaped nest of weed fragments and twigs bound together with a gum secreted from the kidneys. The work of building completed, courtship begins, and this as a rule leads to furious battles with rival suitors. Several wives are in turn, by force or persuasion, led to the nest where the eggs, which are defended by the fickle husband, are deposited. Any creature—another fish, a newt or a beetle—approaching the nursery is immediately assailed by the father "tiddler" with incredible violence. He can inflict painful wounds with his dagger-like spines, and a pitched battle between two of these tiny swashbucklers frequently ends fatally for one or the other.

The more slender Ten-Spined Stickleback, *Pygosteus pungituis*, is less abundant than the above, but is equally adaptable to the aquarium. It differs from the common form in lacking that fish's defensive plates on the side and tail, in having ten spines ranged along its back, and by constructing a nest on different lines. Whereas the "tiddler" builds on the bottom, ram-

ming his nest together by using his snout as a pile driver, his more slender cousin secures his nest to the upright stems of water plants not far from the surface. During the breeding season the male fish, instead of assuming brilliant colours, becomes jet black.

The African and South American family, *Characinidæ*, numbers in its crowded ranks some very formidable forms. All are well armed with powerful teeth, which are sometimes clearly visible when the mouth is closed. Several species grow to a very large size and in the Nile district are called "Dogs of the Water." The "Cariba," *Serrasalmo*, of South America has long been notorious for a very evil reputation, as it grows to over 2 feet in length, and hunts by scent. The faintest tinge of blood in the water at once attracts these fish, and often the mere presence of a warm living body is sufficient to draw them to the feast in vast shoals. Human beings, deer, jaguars and tapirs have been literally hewn to pieces by the



STICKLEBACK.

razor-edged teeth of these indomitable tigers of the river-bed.

Some of the smaller members of the family such as those belonging to the South American genus *Tetragonopterus* do well in the aquarium. Amongst the most attractive of these are the Beacon Fish, *Tetragonopterus ocellifer*, with its flashing ruby-red eye-spots on the tail, and the X-Ray Fish, *Tetragonopterus unilineatus*, whose flesh is so transparent that the internal organs can be quite clearly studied through the body wall.

The Jumping Fish, *Carpeina arnoldi*, is another hardy aquarium fish, remarkable for its breeding habits. The eggs are laid out of the water, the parent leaping clear of the lake or river and depositing the eggs singly on some overhanging leaf or branch, whilst in mid-air. Some 200 eggs are thus installed by the female, who then transfers the parental duties to her partner. His task is to keep the eggs moist until they hatch, which he accomplishes by splashing them by beating the water with his tail.

In striking contrast to some of the formidable fish just described are the members of the family *Cyprinodontidæ*. They are all of very small size with flattened heads. A large number are suitable for exhibition in the aquarium. Some forms are oviparous, whilst others bring forth their young alive.

The Swordtail, *Xiphophorous helleri*, of Mexico is a living gem some 5 inches in length. The sword-like

elongation of the tail fin is essentially a male character, as is the spike-like development of the anal fin which serves as an intromittent pairing organ. The females of these fish in their third year, and after having delivered themselves of their living young, occasionally

SWORDTAIL.

change sex, assuming the male characters. The explanation offered is that as normally the males are far outnumbered by the females the sudden change of sex is an attempt on the part of Nature to equalize the odds, and maintain a sufficient balance of the sexes to ensure the survival of the race. The swordtail frequently

interbreeds with closely allied species. A very beautiful sport—one frequently seen in aquaria—is known as the Golden Swordtail and is the result of a cross between it and a little golden fish, *Platypœcilus maculatus*.

The tiny fish, *Lebistes reticulatus*, known as the " Millions " Fish, one of the hardiest of all the small tropical aquarium fish, has been successfully employed to stem the tide of malaria in the West Indies, as disseminated by the *Anopholes* mosquito, and efforts have been made to acclimatize it in the tropical haunts of the mosquito all over the world. As in the case of most fish the male is much smaller than the female, and is much more brightly clad. The females are simply dull olive grey in colour, whilst the males are conspicuously ornamented with red, blue, violet and yellow, with a dark ocellar spot situated in the middle of the body and another at the base of the tail fin. The males are remarkably active and are perpetually courting the females, going through all kinds of antics in their endeavours to attract attention.

Breeding goes on all the year round, at least in captivity, and the females are in an almost permanently pregnant condition, for within a month of having brought forth a brood of from fifteen to twenty-five young fish, they bring another family into the world. The little " millions " grow rapidly : about 4 m.m. at birth, they double that length in a fortnight or so, when their sex can be determined by the shape and position

of the anal fin; it is not, however, until they are about two months old that the males become adorned with the brilliant markings which characterize the adult.

The Sail Fin, *Mollienesia latipinna*, of Mexico is remarkable for the astounding development of the dorsal fin in the male, the depth of which when fully erect is at least twice that of the body. It is an inhabitant of brackish rivers, but becomes thoroughly acclimatized to fresh-water.

The little minnow-shaped Mother-of-Pearl Fish, *Cyprinodon dispar*, which inhabits the streams of nearly the whole of tropical Asia and Arabia, flourishes in the aquarium at a temperature of 70° F. It is, however, able to withstand tremendous heat, as it occurs in the steaming hot springs of the Hufuf oasis in Arabia, where the temperature never falls below 100°, and sometimes rises to 110°. How the fish found their way to this oasis is a mystery, as the nearest open water system is over 400 miles away from the springs. It has been suggested that their eggs were originally carried attached to aquatic weeds in the claws of birds visiting the springs.

The Dwarf Pike, *Belonesox belizanus*, also of Mexico, is the only aggressive member of the family. This pike-like fish, which rarely measures more than 5 inches in length, adopts the stalking methods of its namesake, engulfing any small animal it can overpower. Newly imported specimens will only feed on living objects

such as small crustaceans, mosquito larvæ, tadpoles, etc., but in time come to appreciate a meal of finely shredded liver or heart.

The Salmon family is in Great Britain represented by several species, of which the trout, and the salmon in its young stages, are the only members to live any length of time in the aquarium.

A veritable flood of literature is annually poured forth as a result of up-to-date investigations into the life-history of the Salmon, *Salmo salar*, at once the most beautiful and valuable of all our fresh-water fishes. The salmon lives in the sea, entering the rivers in about its third year to spawn, and may continue to make annual visits up-stream for this purpose throughout the remainder of its life. When spawning time approaches, the lower jaw of the males becomes greatly enlarged and curls up at the end. The front teeth likewise grow excessively long,—a provision for the courting season in the autumn, when deadly battles take place between rival males for the possession of the females. The " hen "-salmon makes a hollow in the river-bed with her tail and places successive layers of eggs therein, covering each batch with a blanket of gravel. In about four months the infant fish, or *alevins*, hatch out. The young salmon grow 6 to 8 inches in length in the course of their first two years, when they are termed *parr*. They are then light brown in colour with dark blotches or bars, and are difficult to distinguish from trout of the same age. In the follow-

ing year, when in what is known as the *smolt* stage, they assume the bright silvery tints of the adult form, and make for the sea. Having waxed fat in the salt water the fish returns to the river where it was hatched. Its instinct of orientation is developed to a very high degree, for however often it may return it persists in visiting its birthplace.

The salmon carries its life-history indelibly written on its scales, which bear annular rings like those evident in the cross-section of a tree. Where the fish has grown apace and put on much flesh the rings are far apart. Where feeding has ceased, as in the spawning season, the rings are close together. Experts can, by an examination of the salmon's scales, not only estimate the age of a given fish to within a year, but can even sometimes state in what river the fish was hatched. The salmon presents many knotty problems in the aquarium. An effort is being made at the Zoo to gradually acclimatize the fish when they reach the smolt stage to sea-water.

The Brown Trout, *Salmo trutta*, is distinguished from the salmon by several anatomical features. Apart from the difference in colouring and markings, in the position of the upper jaw we have a character by means of which we can distinguish between the two fish, its base in the case of the salmon not extending, or extending but little, beyond the eye, whilst in the trout it reaches far behind that organ. The trout and its varieties are known by hundreds of different

names in Great Britain, although scientific authorities recognize but a single species.

The British Trout, the American Rainbow Trout, *Salmo irideus*, and the American Char, *Salmo fontinalis*, will all thrive in large aquaria provided the water is well aerated and kept throughout the year at a temperature of below 55° F. In warmer water they are liable to a fluke infection of the gills, which usually proves fatal.

The familiar Pike, *Esox lucius*, is abundant in North America as well as in Europe, and since the dawn of history the two continents have vied with each other in the recounting of " fishermen's tales " concerning this ogre of the river. Like all other fish, it grows continuously throughout life, so that it is difficult to assign a size limit for the fish. According to Major S. S. Flower, who has made a study of the duration of life of these animals, nothing very definite can be said as to the age to which a pike may live, but he is of the opinion that giant specimens weighing 60 to 70 lb. are as many years old. Statements that they live for centuries he regards as mere fables. The fish is known by various names,—Gedd in Scotland, Jack, and Pickerel, the latter dating from mediæval times.

The pike is a veritable water tiger, as regards coloration as well as strategy. Its striped sides blend perfectly with the streaky pattern of the flags and rushes, varying in tint with the changing seasons. The fish approaches its quarry with a scarcely perceptible move-

Photograph by] [*Central News.*

PIKE.

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ment. Then suddenly it makes a rush. If unsuccessful it once more settles amongst the weeds, and bides its time until another opportunity offers. Its capacity for nourishment can scarcely be exaggerated. Pike have been known to seize the human hand incautiously dangled over the boatside, and there is an authentic instance recorded of a pike engulfing the head of a swan which happened to be groping for water weeds at the time. Fish, frogs, rats, and young water-fowl are amongst its common victims. That it is an intelligent fish was demonstrated some years ago in a certain aquarium where a specimen kept in a small tank had for its companions several roach. As the pike soon exhibited his aggressive nature, to save the roach, the inexperienced keeper who had introduced them erected a dividing glass partition. The pike persisted in stalking his tank-companions, but with disastrous results to himself. Having struck his snout against the invisible barrier several hundreds of times, it eventually dawned upon him that nothing was to be gained by his attacks, and he eventually lost interest in the subject of roach. Some months later the barrier was removed, but the pike, having grown to associate them with "one on the point," was taking no more chances, and left the roach severely alone. At any rate he never made another attempt upon their lives, although strange fish introduced were immediately attacked and devoured. The male pike suffers much from domestic strife. He is much smaller than the

female, and a prolonged courtship not infrequently ends in the lady making a meal of her suitor.

The Common Eel, *Anguilla vulgaris*, can live in either fresh or salt water. Its romantic life-history, although until quite recently shrouded in mystery, is now more or less common knowledge. Prior to its discovery the eel's existence was explained in many curious ways, the early naturalists being in favour of the theory that the fish were evolved from horse hairs that had fallen into the water. It is now established that the eel breeds far out in the deepest parts of the Atlantic, near the Azores, and that the young, which are at first transparent ribbon-like creatures, travel via the Gulf Stream towards the shores of Europe. On arrival, although very tiny, they have attained the parent form, and at once proceed to invade the rivers in immense numbers. For several years they haunt the fresh-waters, until on reaching maturity they make for the Atlantic breeding grounds, from whence they came, there to propagate their species—and die.

Nothing comes amiss to the eel at dinner-time. Molluscs, insects, fish, water-rats, and young birds " all go the same way home,"—if the eel is large enough to accommodate them. Eels have, in fact, on various occasions, been found choked to death as a result of attempting mouthfuls that proved too big for them.

Although content to lie concealed in the mud by day, the eel becomes very active at night, and when kept in an aquarium, its tank should be securely

covered. Large specimens will travel great distances from one pond to another by wriggling overland, their peculiarly constructed gills enabling them to live for many hours out of water. A Zoo eel persisted in climbing out of its official tank night after night, and establishing itself in one containing some sea-anemones several tanks away. Its determination was such that it eventually had its own way, and with the anemones it lives to this day.

The very large family of Cat Fishes has representatives in every quarter of the globe. A large number occur in temperate waters, whilst the tropical members are legion. The cat fishes form an interesting group. A few are provided with an accessory breathing apparatus which enables them to live out of water for several hours, whilst nearly all can exist in water that would be considered too foul to sustain any ordinary fish. Although the majority are heavy and slow in movement, a large number are well insured against attack, either by their bodies being covered with bony plates, or by possessing sharply pointed fin-rays with which they can inflict highly poisonous wounds. A few enjoy the eel's capacity for travelling overland, and at least one kind emulates the mouth breeder in the nurture of its young.

The term cat fish is, of course, derived from the more or less noticeable barbules which depend from the lips of all the members of the clan, and vary in number from one to four pairs.

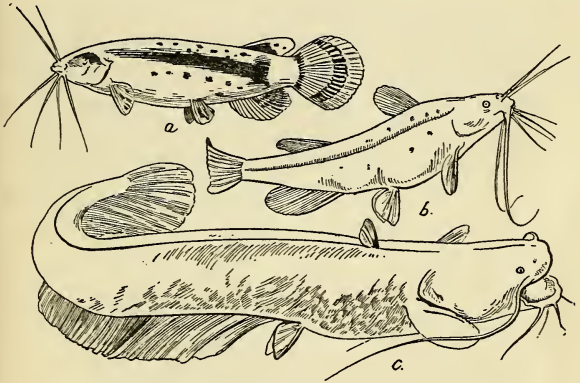
A lavishly whiskered form is the hardy Common American Cat Fish, *Amiurus nebulosus*, which can be bought at all aquarium dealers for a few pence.

Its eggs, which are seldom laid in captivity, are in its native haunts deposited in a nest of mud, the joint work of both parents. On their hatching, the male has been described as leading the young in great schools, caring for them as a hen for her chicks.

The huge Wels, *Silurus glanis*, of Central Europe is abundant in the Danube, where it attains a length of 10 feet and a weight of over 400 lb. The largest European fresh-water fish, it must attain a very great age, as a 4-feet-long specimen living in the Zoo aquarium was received only a few years back from the Duke of Bedford's lake at Woburn into which it had been introduced over fifty years ago. Amongst the queerest of the cat fish that may at any time arrive at the aquarium is the Floating Cat Fish, *Synodontis membranaceus*, of Africa, which is unique in that it elects to spend much of its time swimming upside down with its back fin pointing towards the river-bed, and its " tummy " exposed to the air. In this strange posture it is often depicted in the mural paintings decorating the tombs and monuments of the ancient Egyptians.

Another common African form is the Electric Cat Fish, *Malopterurus electricus*, a dull sluggish creature with a mottled velvety skin and measuring up to 2 or 3 feet in length. Its powerful electric organs extend throughout the entire body and are of unusual interest

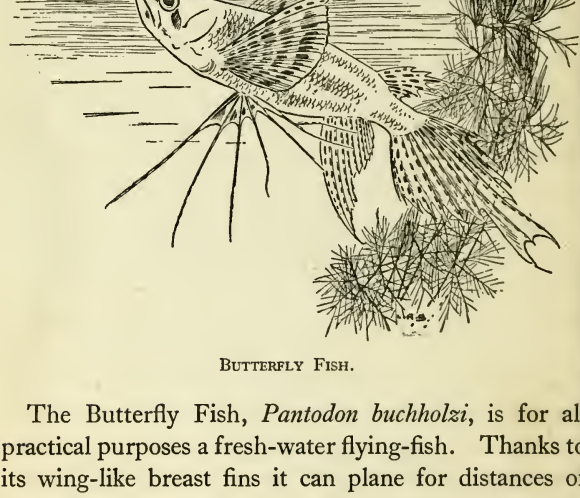
since they are not, as in other electric fish, derived from modifications of the muscular tissue, but are developed from the glandular system. The apparatus is controlled by a single nerve on each side, and can be set working at the will of the fish, which uses its power with often deadly effect. Swimming slowly alongside its prey it suddenly creates a contact by



CAT FISH.
(*a*) Electric Cat Fish. (*b*) Common American Cat Fish. (*c*) Wels.

deliberately touching its quarry, and the force of the shock may be appreciated from the fact that a small specimen will quickly account for all its tank-mates. The strangest feature of this very queer fish lies in that it does not shock other fish to death with the desire of feasting upon them, its object being to force its prey to regurgitate, when it feeds upon the half-digested food vomited forth in the throes of death. The skua

gull appears quite a pleasant character by comparison since, after having secured its meal by bullying methods, it permits its victims to depart little the worse for their rough handling. Known to the Arabs as the " thunder fish," the electric cat fish, contrary to what one might expect, is excellent eating, and regarded by the natives as a great delicacy.



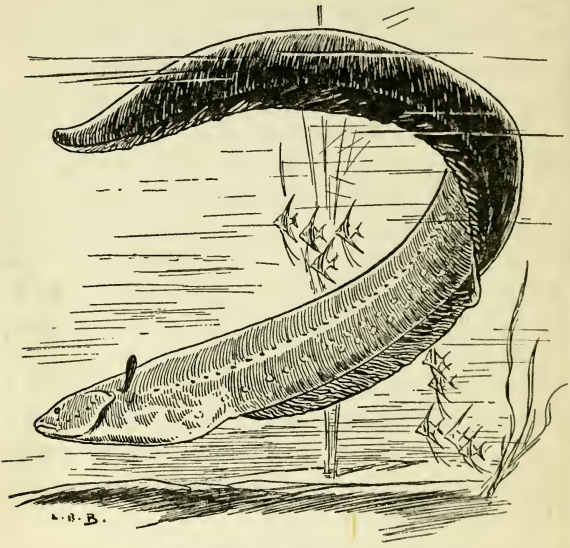
BUTTERFLY FISH.

The Butterfly Fish, *Pantodon buchholzi*, is for all practical purposes a fresh-water flying-fish. Thanks to its wing-like breast fins it can plane for distances of several feet over the water, a faculty which not only enables it to avoid its many foes in the West African rivers it inhabits, but enables it to capture the insects upon which it lives. Its activities are usually confined

to the evening, spending the daytime near the surface of the water where it lays its eggs. The spawn hatches in three or four days at a temperature of 75° F. From thence onwards the aquarist's troubles begin, for the young are not only exceedingly delicate, but grow very slowly and the parents disclaim all responsibility for their upbringing. The first butterfly fish brought to this country was captured in a butterfly net.

The famous but misnamed Electric Eel, *Gymnotus electricus*, of the Amazon River is a very hardy fish, several specimens having been kept at the Zoo for over ten years. Scientifically speaking it is a degraded form of tiger fish, but is much too elongate in form to be known by any other name but that of " eel." The fish grows to a length of 8 feet and is dull grey in colour, except for the lower surface of the body which is cherry red. Four-fifths of the " eel " consists of the tail. Indeed, this organ commences but a few inches from the creature's throat, and in it are stored the electric organs which are modifications of certain muscles, fashioned to form cylindrical cells, packed with a stiff jelly-like substance, richly supplied with nerves. The electric power varies according to the size of the fish, but in very large specimens it has been estimated to be the equivalent of 400 volts. Many are the lurid stories that have been circulated regarding the electric eel. It is undoubtedly a real nuisance to travellers in the swampy districts of the Amazon, often disorganizing their caravans by " shocking " the

beasts of burden. We must, however, accept with caution the vivid accounts of the famous traveller Humboldt, who has asserted that it was occasionally necessary, in order to put the electric eels out of action, to drive a number of horses into the streams or swamps



ELECTRIC EEL.

it was proposed to cross. He has stated that the eels, having expended their electrical powers upon the luckless horses, could be captured and handled with impunity.

We shall conclude our review of the fresh-water

fish that have at one time or other been kept in the aquarium, with the Mud Skipper or Walking Fish, *Periopthalmus Koelreuteri*, a goby previously referred to, inhabiting all the tropical parts of the Eastern Hemisphere, where from the earliest times it has attracted attention by its grotesque form and strange habits. Many fishes, such as the eel, lung-fish, and climbing perch, leave the water when forced to seek fresh pastures owing to drought. The mud skipper, however, does so by choice, and whenever the mood takes him, this quaint little creature with his clownish face, and huge goggle eyes set high up on the head, clambers ashore by means of his stout and supple breast fins, and behaves more like a lizard than a fish. He basks in the sun, and lying at ease on some convenient stump or rock snaps up passing flies inaccessible to the average fish confined to the water. The mud skipper can scuffle along on land at a fair speed, and on alarm will take a header into the water. He, however, rarely ventures "out of his depth," but prefers to rest in shallow water with his head just protruding above the surface.

CHAPTER III

AQUATIC BATRACHIANS

THE name " Batrachian " has been in current use since the days of Linnæus. Prior to that period the frogs and salamanders were known as Amphibians, an elastic term commonly regarded as implying an animal that was unable to live on land, and apt to die in the water,—one, in fact, dependent upon both environments in order to exist.

Batrachians stand midway between the reptiles and the fishes and constitute a link in the chain of evolution. In their early stages they have much in common with fish, whilst on reaching maturity they often bear a superficial resemblance to reptiles. The majority when adult are only partially aquatic, but a few never tear themselves away from their watery nursery and so are eligible for election to the aquarium. Not so very long ago the Batrachians were the subjects of the wildest speculations, and gave rise to the most extravagant stories. It was commonly held, for instance, that frogs descended from the sky,—in conjunction with a heavy rainfall. Toads and newts were believed to spit venom, and the former, supposed capable of living walled up in a rock for centuries, were coveted

by the alchemists for the jewels they were said to carry in their heads. As for the salamanders, all inhabitants of temperate localities, wonderful accounts have been given of their indifference to heat, and of their presence in such resorts as the craters of active volcanoes. Fact, however, is often just as romantic as fiction, and the true life-histories of these creatures display features as marvellous as any invented by the early naturalists.

Living Batrachians are divided into three orders or divisions,—the *Anura*, or Tailless Batrachians; the *Urodela*, or Newts and Salamanders; and the *Apoda*, or Limbless Batrachians.

Certain frogs are entirely aquatic, and of these the Clawed Frogs, *Xenopus*, which are confined to South and tropical Africa, have proved so hardy as to have become universal favourites in the aquarium. A life afloat has developed the hind feet of these frogs into super-paddles, the webs between the toes, which are capped with sharp claws, having become so exaggerated that each foot resembles a half-opened umbrella. Further, as a result of thousands of years of total immersion succeeding generations of clawed frogs have developed highly sensory tubular patches on the skin which are believed to pick up the vibrations of the surrounding water, and thus apprise them of approaching danger. Like all purely aquatic frogs and toads, they have no tongue.

The clawed frog will live for many years in a bowl of

water kept at the temperature of an ordinary living-room if fed on a diet of worms and raw meat. The possibilities of escape need give its owner no anxiety as it never comes ashore, save under compunction of excessive drought or famine, when it may be tempted to make a desperate overland journey in search of more suitable quarters.

These frogs have been induced to breed in this country once only,—at Cambridge. Pairing normally begins in the South African spring, although earlier in northern latitudes. At Cambridge their aquarium was kept very cool for a month, and was then warmed on the approach of their spring, and a few seasonable showers simulated by means of a shower-bath. The male frogs, evidently feeling quite at home, broke their years' silence by giving vent to a love song, resembling the ticking of a watch, and audible at not more than three or four yards' distance. In due course eggs were deposited singly on stones and water plants, and two days later the tadpoles emerged. In the course of a week two long barbules developed on either side of the head, just at the corners of the mouth. By the time the tadpoles were some 4 inches in length the barbules, which act as balancers, were half the length of their wearers. These balancers are highly sensitive, and although at first are mere developments of the epidermis, are later directly connected with the tadpole's brain,—such as it is. Like many other tadpoles, that of the clawed frog is provided on its undersurface with

THE CLAWED FROG TANK.

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a sucker by means of which it anchors itself to any convenient object when it desires to rest.

The Pipa or Surinam Toad, *Pipa americana*, of the West Indies and Northern South America is something of a rarity but has been kept, and induced to breed in the London Zoo. "Child welfare" takes strange forms amongst frogs and toads. Some coil the eggs round their hind limbs, others carry them in their mouths, whilst others again broadcast them on the waters, or attach them to aquatic plants. The mother pipa goes one better, and carries the eggs about upon her back. The eggs are first extruded in a frothy mass, not unlike our common frog-spawn, but are later spread over the back of the mother by her consort. Her spongy skin at the breeding season undergoes a curious development, and becomes so yielding that each egg, enclosed in a fairly tough shell, sinks into a little pit or pocket. As soon as the eggs hatch, their shells are forced upwards and form a series of little caps or lids covering the pits. Thus secure from foes the tadpoles undergo the usual metamorphosis without entering the water, and presently emerge as perfect miniature replicas of their parents.

The mother having rid herself of her seventy odd young,—a very small family for a toad,—rubs off the ragged remnants of their skinny cradles against any convenient object, and looking once more comparatively presentable, returns to the water.

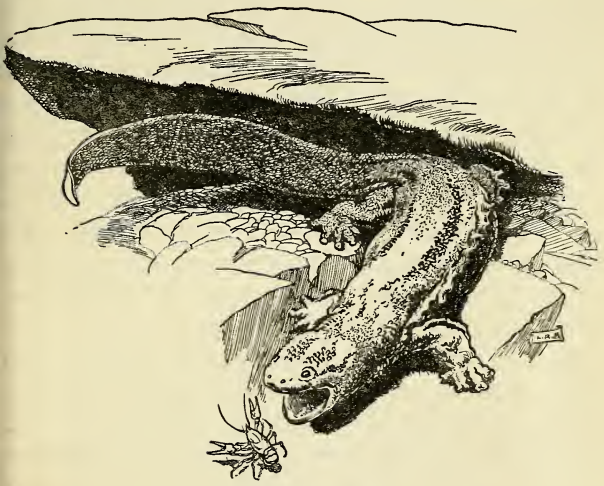
The adult pipa is a strange and unprepossessing

creature. Its head is flat and triangular in shape ; its eyes are minute, and the digits of its fore-limbs terminate in star-shaped fleshy appendages. Flaps of skin are also situated on the upper lip in front of the eyes, and at the angles of the mouth. The toad is entirely aquatic, coming ashore only at the breeding season when the male indulges in vocal efforts scarcely rivalling those of its relative the clawed frog. Whereas *Xenopus* has teeth in the upper jaw, *Pipa* is quite toothless.

It is customary to regard modern animals as being small in size compared with their prehistoric ancestors. This is certainly true in the majority of types, but does not apply to all. In the Batrachians, for instance, a few extinct forms such as the Labyrinthodonts rivalled the largest known crocodiles in bulk, but the frogs and salamanders of to-day are quite as large as their ancient ancestors, and appear to have changed but little since Eocene and Oligocene times. Two kinds of living salamanders may fairly be acclaimed as " giants," and fully equal the monster whose fossil remains were brought to light by one Scheuchzer in 1726. Its skeleton, now in the museum at Haarlem, was labelled " fossil man "—" Homo diluvii testis,"—from which it may be gathered that comparative anatomy was in 1726 still in its infancy. This " fossil man " measured a yard and a half.

To-day may be seen in most large public aquaria salamanders up to 5 or 6 feet in length. The best

known is the Giant Salamander, *Megalobatrachus maximus*, of China and Japan, a creature which frequents mountain streams from four to six hundred feet above sea-level. Its eyes are minute and scarcely discernible amongst the numerous tubercles with which its head and body are covered. The enormous



GIANT SALAMANDER.

mouth, curved in an expansive but quite unmeaning smile, can open and close with surprising rapidity upon unwary fish and crustaceans.

The first specimen was discovered in 1829 and brought to Europe alive. Before its death fifty-two years later it had grown from 1 to 3 feet in length;

a rate of growth which goes to prove that the large specimens measuring over 5 feet must be at least a century old. Since that time many specimens of this spartan batrachian have been brought to Europe and America and all have done well. One that lived in the Amsterdam Aquarium for over forty years, bred there, the young being successfully reared to maturity. The eggs were deposited in the form of a long rosary-like chain, encased in a gelatinous envelope. During their infancy the young salamanders are provided with long external gills, which disappear with age, the fully adult salamander having to make periodic visits to the surface of the water to obtain its supply of air. The sight of the giant salamander is, of course, extremely feeble and it relies upon its unsuspecting prey approaching to within striking distance, which it gauges by the vibrations in the surrounding water.

Sligo's Salamander, *Megalobatrachus sligoi*, which rivals the last mentioned in bulk, is distinguished by its flatter head and smoother skin. The first specimen known appeared in 1922 out of a burst drain-pipe in the Botanical Gardens at Hong-Kong after a torrential rainfall. The creature, now an inmate of the Zoo aquarium, was probably introduced into Hong-Kong from the mainland.

The giant Oriental salamanders have a near relative in the smaller Hellbender, *Cryptobranchus alleghaniensis*, of North America. It is a dark brown, rather shapeless beast, and bites savagely when handled,

although this scarcely seems to justify quite as lurid a name as that by which it is known in America. Largely omnivorous, it is particularly addicted to crayfish. It attains a length of 2 feet.

The Mud Puppy, *Necturus maculosus*, of the Eastern United States is brown in colour with black spots, and with large delicately shaped external gill-tufts of a vivid crimson set on short thick stalks,—organs in marked contrast to those of the adult Hellbender in which the presence of the gills are only revealed by an almost invisible longitudinal slit. The mud puppy has short stoutish limbs, each provided with four digits, but which are not much used, the animal progressing chiefly by means of eel-like movements of the body. It is of sluggish disposition, coming forth from its various retreats only at night when it hunts for the worms and crustaceans upon which it lives.

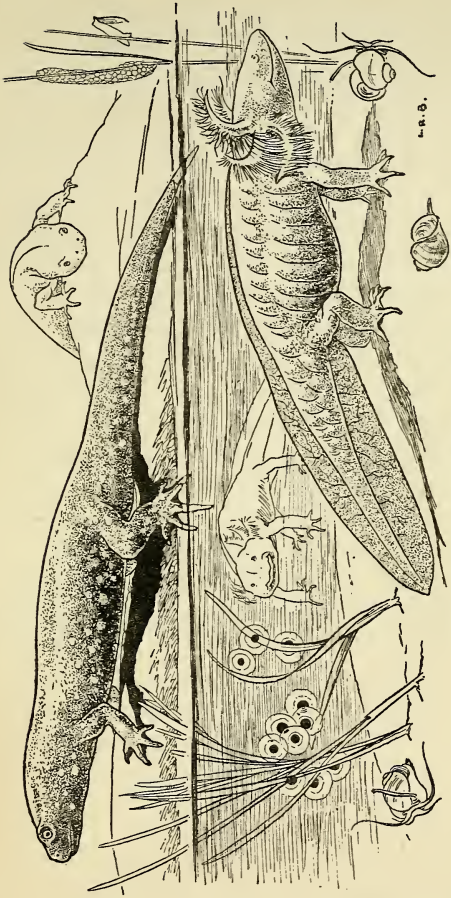
The Proteus, *Proteus anguinus*, is a blind, eel-shaped salamander with external gills and degenerate limbs, the front pair bearing three and the back pair only two toes each. It is a cave-dweller, living in complete darkness in the subterranean lagoons formed by the River Poik in Jugo Slavia, where it plunges underground and passes through a series of vast caverns. Proteus is of a deathly white colour and is totally blind, the eyes only being visible in its quite young stages when the hind limbs are toeless stumps.

This degenerate salamander is remarkably hardy. Specimens have been kept in dark tanks at the Zoo for

very long periods and have proved capable of fasting for years on end. Cold clear water and darkness are all that this strange creature demands in order to "enjoy life." If exposed to the light of an ordinary aquarium, its skin, which is as sensitive as a photographic plate, will turn black.

The Siren or Mud Eel, *Siren lacertina*, of North America has no hind limbs. When young it displays three external gill-tufts on either side of the neck, but as it approaches maturity they disappear, as though the animal had thoughts of becoming a terrestrial salamander. Called siren from its habit of sitting in the water with the head and front part of the body exposed, it haunts shallow ponds and ditches where it feeds chiefly on frogs.

The Axolotl, *Amblystoma tigrinum*, originally a native of Mexico, is bred in large numbers in captivity in Europe and the United States. Outwardly it is a clumsily built tadpole-like creature some 6 to 8 inches in length, black or white in colour, and having on either side of its thick bull-shaped neck a series of long gill-tufts. Under certain special conditions it turns into a salamander. For many years the perfect form was known in the United States, but it was never associated with the axolotl of Mexico,—the two being regarded as quite different animals. Their relationship was established about fifty years ago when some axolotls, received in Paris from Mexico, there laid eggs which in time gave rise to creatures with external gills and



Axolotl (*Amblystoma tigrinum*).

fins just like their parents. The water in their tanks having been allowed to slowly evaporate, these axolotls lost their gills and fins, developed eyelids, and finally left the water and revealed themselves as land salamanders identical with the well-known salamander, *Amblystoma tigrinum*, of the United States. In short, if allowed to spend their whole life in their watery nursery, the axolotl is perfectly willing never to grow up. It is one of the few examples we have of an animal breeding in the larval condition.

Recent researches have cast further light upon this remarkable case of arrested development. It has recently been established that axolotls can be, to use a vulgarism, "gingered up" by injections or meals of thyroid gland or pituitary gland. Indeed, a single meal of ox or sheep thyroid will, within a month, force an axolotl to renounce the water and develop all the attributes of a perfect salamander.

Most of the axolotls living in European aquaria are descendants of the few original pairs which bred in Paris.

CHAPTER IV

AQUATIC MAMMALS

THE aquarium should, strictly speaking, embrace everything—plant or animal—that spends the major portion of its life in the water. It follows that certain thoroughly aquatic mammals should form part of the collection of the ideal aquatic zoo. Nearly all such animals, however, apart from making a deafening noise, invariably foul the water, which, being circulated throughout the tanks, soon proves fatal to the other occupants of the aquarium. Where the water can be pumped direct from the sea, and each tank enjoys a separate circulatory system, aquatic mammals have been kept from time to time in captivity with varying success.

The old Westminster Aquarium at one time exhibited a mermaid alive, the lady's fore-part being provided by one of the finest swimmers of the period. The London Zoo and the New York Aquarium, with a greater regard for the truth, later contented themselves with showing those curious animals which are believed to have given rise to the mermaid stories. These, the

vegetarian Manatees or Sea Cows,—grotesquely human-looking creatures, especially the females, which have very large breasts,—are much given to posing waist high out of the water. The New York Aquarium, with its fine position close to the sea and unusual transport facilities, has kept several specimens at various times, whilst a half-grown individual lived for several months in a heated floor pool in the London Zoo's reptile house.

The White Whale has occasionally been shown in aquaria, but with less success than that attending recent efforts to keep porpoises in captivity. At one time the New York institution showed some Bottle-nosed Dolphins, whilst Brighton during the past thirty years has exhibited a few specimens. One lived for nearly two years.

The late lamented " Percy "—a Common Porpoise, caught off Brighton in a herring-net—was typical of his race. He showed great intelligence and inquisitiveness, and learnt to take food from the hand after only a fortnight of confinement. He consumed thirty pounds of fish a day, and during his few months of public life put up a non-stop swim, covering over one hundred and eighty miles in every twenty-four hours. He died of heart failure and subsequent drowning.

The members of the whale family, apart from demanding enormous tanks, present another very serious problem for the aquarist. So great is the heat radiated

THE SEA LION TANK.

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from their bodies, that unless special provision is made the water of their tank becomes too hot to be supportable.

This closes the list of purely aquatic mammals shown in aquaria. The semi-aquatics include a large number of widely contrasted animals—polar bears, otters, beavers, seals, and sea-lions, and some have been shown under water with charming results.

The Sea-Lion is a popular aquarium exhibit,—until he falls foul of the authorities, which he invariably does, sooner or later. Take the case of " Roary," the star performer of a famous troupe. Roary spent some weeks in every year " resting " at an aquarium. One year he was the guest of the Amsterdam Aquarium, where all went well until one morning the curator found every tank either completely devoid of fish, or filled with the dead and mutilated. The explanation came when Roary was discovered shockingly inflated, sleeping off the effects of his orgy outside one of the storerooms. He had climbed out of his aquarium, forced his way into the service gallery, and visited each tank in turn, eating until gorged, and then killing and maiming from sheer sport.

The following year Roary went to the Brighton Aquarium. Upon a certain afternoon during his stay there the adjoining concert hall was packed with an expectant audience gathered to hear a world-famous singer render the " Lost Chord." Few can hear the song without some emotion. Roary certainly could

not. He held out for a few bars, and then drowned voice and organ in a salvo of raucous barks.

He finished his holiday in the sea-lion pond in Regent's Park.

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